Best Available Retrofit Technology
Technical Support Documentation

Iowa Department of Natural Resources
Air Quality Bureau

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v1.7.2 (draft final)

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1. INTRODUCTION

1.1 PURPOSE

The following document details the methods and procedures applied by the Iowa Department of Natural Resources (IDNR) in assessing if a Best Available Retrofit Technology (BART)-eligible source is subject to BART. Specifically addressed are the mechanisms, analyses, and results which determine if a BART-eligible source can reasonably be anticipated to cause or contribute to any visibility impairment in any federally mandated Class I area.

1.2 BACKGROUND

On June 15th, 2005, the *"Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations"* final[1] rule was published in the Federal Register (70 FR 39104), amending 40 CFR Part 51 and creating Appendix Y. In conjunction with the Regional Haze rule (64 FR 35714) and the Clean Air Act, the BART rule[2] defines BART-eligible sources as: "those sources which have the potential to emit 250 tons or more of a visibility-impairing air pollutant, were put in place between August 7, 1962 and August 7, 1977, and whose operations fall within one or more of 26 specifically listed source categories." Following identification, the Clean Air Act (169A) requires a State to determine whether any BART unit "emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility in any [Class I] area." A BART-eligible source which causes or contributes to visibility impairment in any Class I area is subsequently subject to BART. BART is defined as an "emission limitation based on the degree of reduction achievable through the application of the best system of continuous emission reduction for each pollutant which is emitted by an existing stationary facility" (40 CFR § 51.301). Following an affirmative subject to BART declaration, establishing BART emission limits requires consideration of five factors: 1) the cost of compliance; 2) energy and non-air quality environmental impacts; 3) existing pollution control technology in use at the source; 4) the remaining useful life of the source; and 5) the degree of improvement in visibility expected from the use of best available retrofit technology controls.

The BART rule provides thresholds defining the terms 'cause' and 'contribute': a single source which imparts a change in visibility of 1.0 (or more) deciviews at any Class I area is considered a cause of visibility impairment; a single source contributes to visibility impairment at (or above) the 0.5 deciview level. States are afforded the opportunity to enact more stringent de-minimus levels should they choose. The IDNR believes these thresholds to be adequate and will not propose alternatives. While States are offered discretion regarding the technical tools utilized in determining a single sources' impact on visibility impairment, the BART Guidelines establish implementation of the CALPUFF air quality modeling system as the preferred method. For BART-eligible sources located within Iowa, the CALPUFF modeling system is shown to be inadequate at reasonably characterizing their visibility impacts upon nearby Class I areas. IDNR is thereby implementing a multivariate system which includes Q/d screening methods, emission inventory scale analyses, CALPUFF model plant analyses, and regional scale one-atmosphere photochemical grid modeling.

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[1] Minor technical and typographical errors were corrected in a memo published June 24th, 2005.
[2] Note: The final BART rule (70 FR 39104) may also be referred to as the BART Guidelines within this document.

2. BART-ELIGIBLE SOURCES

2.1 IDENTIFICATION

On February 21st, 2005, the Environmental Protection Commission adopted into the Iowa Administrate Code rule 567-22.9 *Special Requirements for Visibility Protection.* Effective as of April 20th, 2005, the rule established BART-eligible source identification procedures. BART-eligible sources were required to self-identify by completing and submitting BART-Eligibility Certification Form #542-8125 no later than September 1st, 2005. Information provided included: source identification, description of processes, potential emissions, emission unit and emission point characteristics, date construction commenced and date of startup. BART-eligible units were thus identified by rule through a source's duty to self-identify. On May 1st, 2007, rule 22.9 was amended[1] to clarify BART-eligible source category definitions. The original rule encompassed fossil–fuel boilers, or combinations thereof, totaling more than 250 million Btu per hour heat input. The rule was modified in accordance with the BART Guidelines to include only fossil–fuel fired boilers with an individual heat rate greater than 250 million Btu per hour. Our rule modification occurred successive to the required submittal date of the BART-Eligibility Certification Form, therefore IDNR staff reviewed all in-house permitting, Title V databases, and BART forms, to eliminate any source incompatible with the modified requirement. After final review of all submitted applications, 27 BART-eligible sources were identified. Table 2-1 lists the facilities operating BART-eligible units. A regional perspective is provided in Figure 2-1 while Figure 2-2 clarifies the individual BART-eligible facility locations.

2.2 CATEGORIZATION

Of the 27 facilities containing BART-eligible units, 13 facilities are classified as electrical generating units (EGUs). Each BART-eligible EGU is subject to the Clean Air Interstate Rule (CAIR) in terms of the annual sulfur dioxide (SO2) trading rules as well as the annual and seasonal oxides of nitrogen (NOx) trading rules. As explained in the BART Guidelines and codified at 40 CFR § 51.308(e)(4), EPA has determined participation in CAIR may serve as a substitute to BART. Specifically, participation in CAIR achieves BART requirements in terms of NOx and SO2 emission limits given participation in SO2 and NOx trading rules. IDNR is utilizing CAIR in lieu of BART respective of BART-eligible EGU NOx and SO2 emissions.

The Clean Air Interstate Rule is limited in terms of a negative subject to BART declaration as CAIR does not address all five[2] visibility impairing pollutants, nor are non-EGU sources addressed. Therefore BART-eligible EGU particulate matter (PM), volatile organic compounds (VOC), and ammonia (NH3) emissions must be evaluated. Additionally, subject to BART determinations for the 14 non-EGU BART-eligible sources require the consideration of all five visibility impairing pollutants. The following chapters thus focus upon the methods and results associated with determining if any emissions of visibility impairing pollutants from a non-EGU BART-eligible source, or if any PM, VOC, or NH3 BART-eligible EGU emissions, may be reasonably anticipated to cause or contribute to visibility impairment at any Class I area.

[1] Concurrently rule 22.9 was expanded to address regional haze program requirements as in 40 CFR § 51.308.
[2] SO2, NOx, VOC, particulate matter, and NH3

Table 2-1. Iowa's BART-Eligible facilities.

Source Category Name	Facility Number	Facility Name	BART Emission Units	BART Unit Count
Fossil Fuel-fired Steam Electric Plant Individually Greater than 250 MMBtu/hour (Electrical Generating Units or EGUs). **Note: These units are subject to the Clean Air Interstate Rule.**	07-02-005	Cedar Falls Utilities	Streeter Unit #7 (EU10.1A)	1
	88-01-004	Central Iowa Power Cooperative (CIPCO) - Summit Lake	Combustion Turbines (EU1, EU1G, EU2, EU2G)	4
	70-08-003	Central Iowa Power Cooperative (CIPCO) – Fair Station	Unit # 2 (EU2 & EU2G)	2
	85-01-006	City of Ames - Steam Electric Plant	Boiler #7 (EU2)	1
	29-01-013	Interstate Power and Light - Burlington	Main Plant Boiler. Twenty-one units in total.	21
	03-03-001	Interstate Power and Light - Lansing	Boiler #4. Sixteen units in total.	16
	23-01-014	Interstate Power and Light - ML Kapp	Boiler #2. Six units in total.	6
	57-01-042	Interstate Power and Light - Prairie Creek	Boiler #4. Fourteen units in total.	14
	78-01-026	MidAmerican Energy Company - Council Bluffs	Boiler #3 (EU003)	1
	97-04-010	MidAmerican Energy Company - George Neal North	Boilers #1-3 (EU001 - EU003)	3
	97-04-011	MidAmerican Energy Company - George Neal South	Boiler #4 (EU003)	1
	70-01-011	Muscatine Power and Water	Boiler #8	1
	63-02-005	Pella Municipal Power Plant	Boilers #6-8	3
Chemical Process Plant	23-01-004	Equistar Chemicals	301 emission units	301
	94-01-005	Koch Nitrogen Company	Ammonia vapor flares and primary reformer/auxiliary boiler. Eight units in total.	8
	70-01-008	Monsanto Company Muscatine	Boilers #5-7. Fifty-seven emission units in total.	57
	97-01-030	Terra Nitrogen Port Neal	Boiler B & Auxiliary Boiler	2
Petroleum Storage and Transfer Units[1]	82-02-024	BP - Bettendorf Terminal	Truck loading	1
	77-01-158	BP - Des Moines Terminal	Truck loading	1
Portland Cement Plant	17-01-009	Holcim (US) Inc.	109 emission units	109
Fossil Fuel-fired Boiler	23-01-006	ADM (Clinton)	No. 7 & 8 Boilers. These boilers will be permanently shut down by 09/13/2008.	2
Iron and Steel Mills	26-01-001	Bloomfield Foundry, Inc.	18 emission units	18
	78-01-012	Griffin Pipe Products Co.	10 emission units	10
	07-01-010	John Deere Foundry Waterloo	37 emission units	37
	56-01-025	Keokuk Steel Castings, A Matrix Metals Company LLC	67 emission units	67
	51-01-005	The Dexter Company	Tumblers 5 & 6	1
Secondary Metal Production	82-01-002	Alcoa, Inc.	Hot line mill. Eighty-seven emission units in total.	87

[1] Total storage capacity exceeding 300,000 barrels.

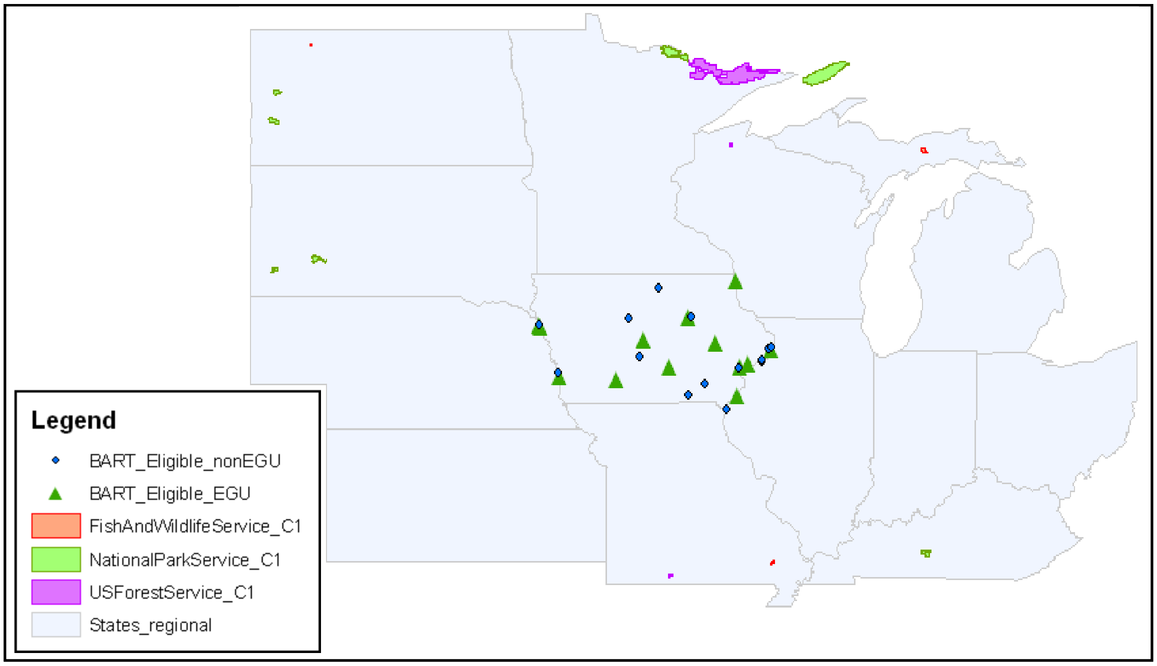

Figure 2-1. Regional overview of BART-eligible facilities within Iowa.

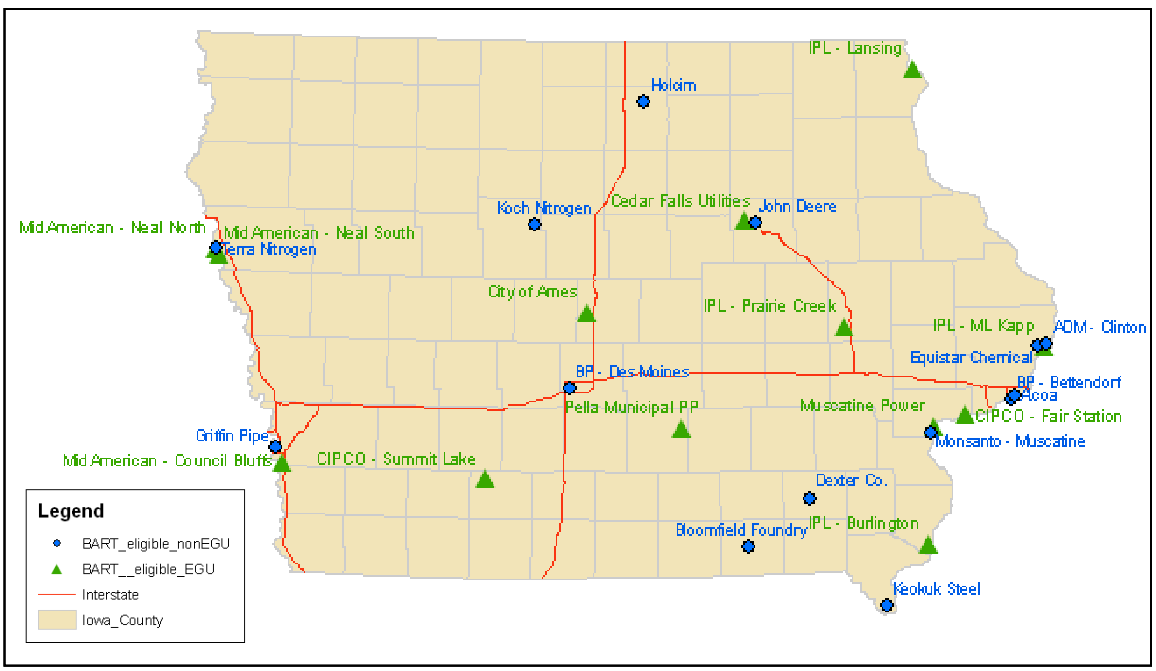

Figure 2-2. Individually labeled and categorized (EGU/non-EGU) BART-eligible facility locations.

3. SUBJECT TO BART METHODOLOGY

3.1 INTRODUCTION

In order to remain consistent with the guidelines established in the BART rule, the IDNR devoted extensive personnel and computational resources toward implementation of the CALPUFF modeling system in development of a scientifically sound modeling protocol for subject to BART determinations. Iterative CALPUFF simulations were investigated to identify a refined configuration capable of accurately characterizing a BART-eligible source's visibility impact upon nearby Class I areas. After considerable study IDNR has concluded that the preferred source-specific/receptor-specific application of the CALPUFF modeling system fails to provide technically defensible results for applications unique to Iowa facilities.

Sources within Iowa's borders share the distinct geographical characteristic where they are assured that the separation distance to the border of their nearest Class I area will exceed 300 kilometers (see Figure 3-1). In reference to Iowa's BART-eligible sources (see Table 2-1), the minimum separation distance is 392 km with an average of approximately 516 km. IDNR acknowledges CALPUFF has been adopted by EPA in the Guideline on Air Quality Models (40 CFR Part 51 Appendix W) as the preferred model for assessing long range transport of pollutants and their impacts on federal Class I areas. IDNR agrees CALPUFF is suited for a variety of single-source impact analyses, however, IDNR has not identified data or studies supporting the appropriateness of CALPUFF in applications with minimum transport distances of nearly 400 km.

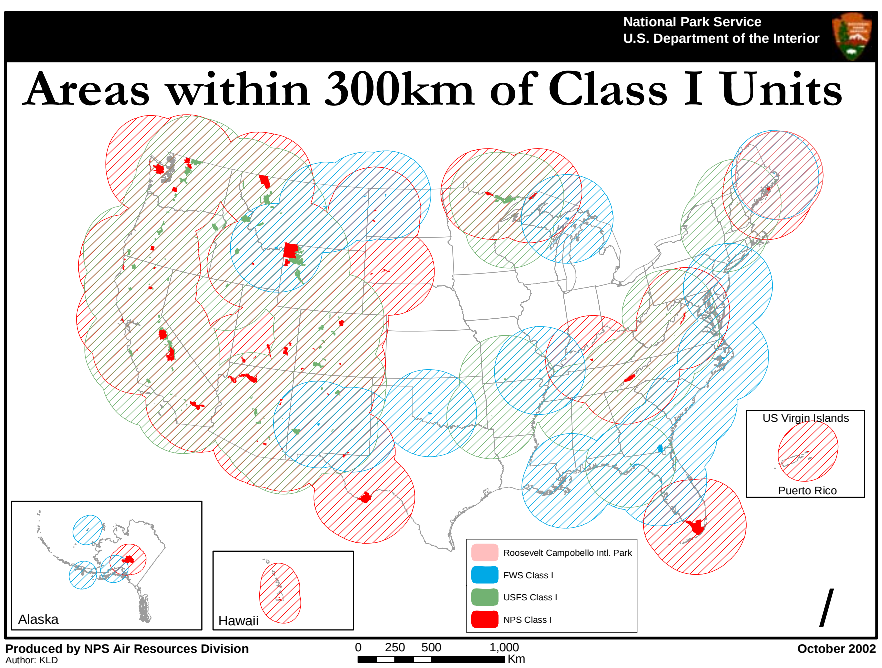

Figure 3-1. Areas within 300 km of a Class I area. Iowa is the only state whose border does not intersect a 300 km buffer zone.

Through design and implementation CALPUFF is typically configured to err conservatively in the prediction of ambient air pollutant concentrations. However, the levels of conservatism encountered by the IDNR are more appropriately described as model bias. As noted in the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 report (EPA, 1998):

> *"...there are serious conceptual concerns with the use of puff dispersion for very long-range transport (300 km and beyond). As the puffs enlarge due to dispersion, it becomes problematic to characterize the transport by a single wind vector, as significant wind direction shear may well exist over the puff dimensions."*

IDNR has implemented puff-splitting in an attempt to alleviate the errors, however, as noted in the CENRAP BART Modeling Guidelines (Alpine Geophysics, 2005):

> *"Detailed guidance on when and how the puff-splitting algorithm should be used and actual verification studies demonstrating that the technique operates as intended are not discussed in the model documentation or presented in the science literature."*

The IDNR chose to investigate puff-splitting as a potential means of justifiably retaining a traditional CALPUFF implementation. The investigation confirmed the hypothesis that puff-splitting would reduce maximum impacts versus an otherwise identical simulation. For example, puff-splitting reduced the twenty-four hour averaged maximum deciview (dv) impacts[1] an average of 0.14 dv. Unfortunately the costs associated with puff-splitting involve a near 60-fold increase in run-time, while serious abnormalities remained in the solutions. Figure 3-2 depicts maximum deciview impacts as a function of distance. These results were generated from ten independent simulations, with each run employing puff splitting. A single theoretical source located in central Iowa was modeled, with emissions of 2500 tons per year (tpy) of NOx and SO2 each and 50 tpy of PM. Discrete concentric receptors separated by one degree were defined. Only one variable, the radius of the receptor ring, was modified between runs. Beyond approximately 450 km, maximum impacts increase monotonically. These results are non-physical given the operational design and chemical mechanisms of the CALPUFF modeling system. As the majority of Iowa BART sources are positioned beyond 450 km from their nearest Class I area, application of CALPUFF will be limited to a model plant approach in which source-receptor distances remain below 450 km. Such constraints minimize the importance of CALPUFF transport mechanisms while simultaneously avoiding interpretation of results which are highly suspect of unacceptable overprediction.

3.2 VARIEGATED ASSESSMENT

Given the concerns associated with application of the CALPUFF modeling system in a setting which may exceed its operational design, the IDNR is utilizing a multivariate approach in the subject to BART determination process as an alternative to sole reliance upon the CALPUFF modeling system. CALPUFF will be used in a model plant approach in order to generate emission rate thresholds which inform subject to BART determination decisions. In the near term, simple screening procedures are conducted using Q/d methodology. A third phase of the multiform approach includes a variety of assessments utilizing the CAMx regional scale one-atmosphere model. The final mechanism completing the weight of evidence approach involves emission inventory scale analyses.

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[1] Generated using the configuration relative to Figure 3-2 with a receptor radius of 425 km. The 0.14 dv reduction represents the average of the seven differences calculated for each Class I area indicated in Figure 3-2.

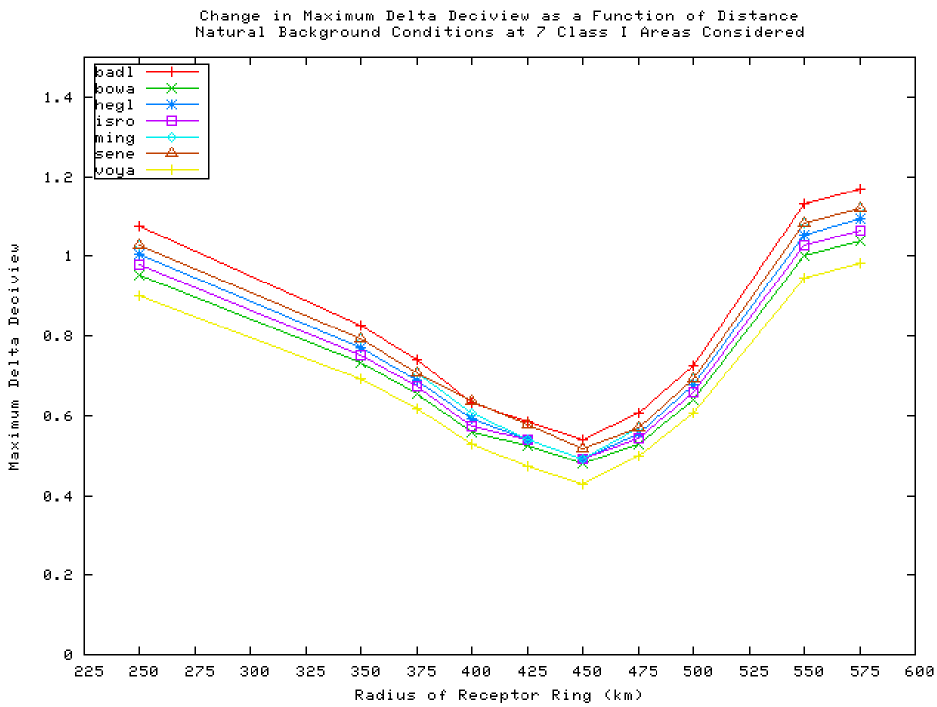

Figure 3-2. Maximum deciview impacts as a function of distance. Generated using the IDNR model plant configuration with 2500 tpy of SO2 and NOx emissions each, and 50 tpy of PM (modeled as PM2.5), for calendar year 2002. Results from seven Class I areas are depicted. (Class I variations reflect site specific f(RH) data only and are not dependent upon actual spatial location. Data evaluated against annually averaged natural background conditions. (The model plant configuration is explained further in Chapter 5.)

4. Q/D METHODOLOGY

4.1 CALCULATION

A Q/d (emissions divided by distance) screening approach is used to determine those sources which are probable candidates for exclusion from BART. Emissions, designated as Q (in tons per year), represent the summation of emissions across all BART-eligible units at a given facility. The value "d" (specified in kilometers) is determined as the distance between the location of the BART source and the nearest Class I area gridded 1 km receptor. The Class I area 1 km receptor database[1] was developed by the National Park Service (NPS) and includes all Class I areas in the contiguous 48 states. An improved approach[2] to spherical trigonometry, as described by Sinnott (1984), was utilized to calculate the separation distance between a BART facility and the nearest Class I area 1 km discrete receptor. The NPS receptor data serve as an accurate proxy to GIS derived border data, and accommodate calculation of Q/d through spreadsheets. An independent check of the distance calculations was conducted through implementation of GIS techniques. The review revealed near perfect agreement (Gail George of the IDNR, personal communication, 2005).

The Q/d values calculated for each of the 14 non-EGU[3] BART-eligible sources are provided in Table 4-1 with the nearest Class I area listed in Table 4-2. Q/d calculations are compiled for both potential and actual emissions. Potential emissions include only BART-eligible units while actual emissions represent facility wide totals, thus in certain cases actual emissions may exceed potentials. Although EPA proposed potential PM2.5 emissions be included in the summation of Q, PM2.5 emission rates are unavailable. PM10 emissions were selected as a surrogate. Q therefore sums NOx, SO2 and PM10 emissions.

4.2 EVALUATION

The Q/d values for three prescribed constants are compared against a significance level of 1. Standard procedures, such as the "Screening Threshold" method for Prevention of Significant Deterioration (PSD) modeling originally developed by the North Carolina Department of Environment and Natural Resources (1985), have typically used a constant of 20. The IDNR has calculated Q/20d as well as the more conservative Q/10d (utilization of Q/10d values is common practice by the NPS in PSD increment consumption analyses). Further conservatism is incorporated through calculation and consideration of Q/5d values. As indicated above, Q/d values are provided for both potential and actual emissions.

[1] Data available at: http://www2.nature.nps.gov/air/Maps/Receptors/index.cfm
[2] Method available at: http://tchester.org/sgm/analysis/peaks/how_to_get_view_params.html
[3] Due to CAIR, Q/d values for EGUs were not evaluated.

Table 4-1. Q/d values for non-EGU BART-eligible sources.

Facility Number	Facility Name	Distance (km)	BART Units Potential Emissions (tpy)							Facility Wide Actual Emissions (tpy)						
			SO2	NOx	PM 10	VOC	Q/20D	Q/10D	Q/5D	SO2	NOx	PM 10	VOC	Q/20D	Q/10D	Q/5D
23-01-004	Equistar Chemicals	531.2	3,883	3,433	258	17,894	0.71	1.43	2.85	1	728	52	2,310	0.07	0.15	0.29
94-01-005	Koch Nitrogen Company	615.4	40	1,399	23	11	0.12	0.24	0.48	0	442	20	2	0.04	0.08	0.15
70-01-008	Monsanto Company Muscatine	486.8	430	168	81	153	0.07	0.14	0.28	465	192	8	16	0.07	0.14	0.27
97-01-030	Terra Nitrogen Port Neal	487.6	1	916	325	5	0.13	0.25	0.51	1	461	33	19	0.05	0.10	0.20
82-02-024	BP - Bettendorf Terminal	499.9	0	0	0	298	0.00	0.00	0.00	0	0	0	153	0.00	0.00	0.00
77-01-158	BP - Des Moines Terminal	547.0	0	0	0	301	0.00	0.00	0.00	0	0	0	169	0.00	0.00	0.00
17-01-009	Holcim (US) Inc.	527.1	28,715	4,738	1,000	27	3.27	6.54	13.07	3,826	2,813	190	15	0.65	1.30	2.59
23-01-006	ADM (Clinton)	531.9	6,051	2,117	507	8	0.82	1.63	3.26	6,479	5,003	1,272	2,790	1.20	2.40	4.80
26-01-001	Bloomfield Foundry, Inc.	448.8	136	68	605	64	0.09	0.18	0.36	1	0	22	3	0.00	0.01	0.01
78-01-012	Griffin Pipe Products Co.	563.6	190	235	211	586	0.06	0.11	0.23	2	88	111	260	0.02	0.04	0.07
07-01-010	John Deere Foundry Waterloo	588.8	0	0	285	172	0.02	0.05	0.10	9	21	99	115	0.01	0.02	0.04
56-01-025	Keokuk Steel Castings	392.0	11	72	554	406	0.08	0.16	0.32	4	9	67	111	0.01	0.02	0.04
51-01-005	The Dexter Company	468.9	0	0	541	0	0.06	0.12	0.23	29	3	112	11	0.02	0.03	0.06
82-01-002	Alcoa, Inc.	501.8	15	400	1,092	317	0.15	0.30	0.60	2	137	209	296	0.03	0.07	0.14

Table 4-2. Nearest Class I area for non-EGU BART-eligible facilities.

Facility Name	Nearest Class I Area	Distance (km)	Facility Name	Nearest Class I Area	Distance (km)
Equistar Chemicals	Mingo	531.2	ADM (Clinton)	Mingo	531.9
Koch Nitrogen Company	Boundary Waters Canoe Area	615.4	Bloomfield Foundry, Inc.	Hercules-Glades	448.8
Monsanto Company Muscatine	Mingo	486.8	Griffin Pipe Products Co.	Hercules-Glades	563.6
Terra Nitrogen Port Neal	Badlands	487.6	John Deere Foundry Waterloo	Boundary Waters Canoe Area	588.8
BP - Bettendorf Terminal	Mingo	499.9	Keokuk Steel Castings	Mingo	392.0
BP - Des Moines Terminal	Hercules-Glades	547.0	The Dexter Company	Mingo	468.9
Holcim (US) Inc.	Boundary Waters Canoe Area	527.1	Alcoa, Inc.	Mingo	501.8

4.3 RESULTS

The non-EGU BART-eligible sources are easily classified into three groups based upon the Q/d evaluation. Facilities clearly exceeding the 1.0 threshold, sources well below the threshold, and those with mixed results. Holcim and ADM (Clinton) exceed 1 in almost every Q/d calculation and clearly require more refined analyses. Alternatively, the majority of non-EGU facilities remain well below the screening threshold in all six Q/d tests. The eleven facilities listed in Table 4-3 yield Q/d values well below 1.0 at even the most stringent potential to emit Q/5d evaluation and subsequently are unlikely to be considered subject to BART. This conclusion is further supported through evaluation of the Q/d values based upon facility-wide actual emissions. The actual emission Q/5d values average 0.09, with the upper limit established by Monsanto Company Muscatine at only 0.27. These low values suggest any emission reductions would be imperceptible at the nearest Class I area.

Table 4-3. Non-EGU BART-eligible facilities significantly below all Q/d screening thresholds.

Koch Nitrogen Company	Griffin Pipe Products Co.
Monsanto Company Muscatine	John Deere Foundry Waterloo
Terra Nitrogen Port Neal	Keokuk Steel Castings
Bloomfield Foundry, Inc.	The Dexter Company
BP - Bettendorf Terminal	Alcoa, Inc.
BP - Des Moines Terminal	

Equistar Chemical initially emerges in a gray area. Considering potential emissions, the Q/20d value is 0.71 with Q/10d and Q/5d exceeding 1.0. Actual emissions reveal a different situation. The most conservative value, Q/5d, remains well below 1 at 0.29. Equistar Chemical reported facility wide SO2 emissions in 2002 at one ton per year, with NOx emissions of 728 tpy. As shown in Table 4-2, the nearest Class I area receptor is located within the Mingo Wilderness Area, at a distance of approximately 531 km. By definition, the great transport distance in combination with low actual emissions produced the low Q/d value. Under these circumstances, Equistar Chemical remains unlikely to be considered subject to BART. Prior to any subject to BART exemption, results from additional analyses will be considered.

5. CALPUFF MODEL PLANT

5.1 INTRODUCTION

Implementation of the CALPUFF modeling system occurs through a 'model plant' assessment for screening sources which are not reasonably anticipated to cause or contribute to visibility impairment at nearby Class I areas. The IDR model plant analyses follow the theory outlined in the technical support documentation (EPA, 2005b) referenced in the BART Guidelines. The IDNR model plant configuration utilizes methods similar to those incorporated in more traditional (refined) BART applications, and follows the IDNR CALPUFF protocol[10] (2005). Primary asymmetries between refined evaluation and the IDNR model plant approach include utilization of a representative plant (*e.g.* idealized stack parameters and centralized location) and a ring of receptors around the model plant versus source specific stack parameters coupled with receptors located within Class I areas. A detailed description of the IDNR model plant configuration is provided within Section 5.2.

5.2 MODELING SYSTEM CONFIGURATION

Application of the CALPUFF modeling system, whether in a model plant framework or a site specific application, requires the completion of four operational tasks:

1) developing a three dimensional modeling domain
2) generation of meteorological fields appropriate for CALPUFF simulations
3) specification of appropriate options within modeling system control files
4) quantitatively (in terms of deciviews) characterizing the visibility impairment attributable to a BART-eligible source upon nearby Class I areas

Successful implementation of the modeling system involves refinement of model configuration parameters and generation of complex meteorological datasets. To assist with the process, EPA recommends following the IWAQM Phase 2 framework. EPA recognizes the IWAQM framework may be unsuitable in certain situations, such as those involving extensive transport distances, thus States are not restricted from making appropriate modifications. As all BART-eligible sources within the State of Iowa share the unique geographical characteristic where the separation distance between a source and the nearest neighboring Class I area exceeds ~390 kilometers, not all IWAQM recommendations are appropriate. Deviations from the IWAQM recommendations deemed necessary to provide a more robust analysis or conserve computational and/or personnel resources, while maintaining technical defensibility, are noted.

5.2.1 VERSION CONTROL

Based upon verbal comments received from EPA Region VII, the IDNR implemented a beta[11] version of the CALPUFF modeling system. Table 5-1 details the version and level uniquely defining each program. Processor arrangement in Table 5-1 corresponds to the order in which the programs are invoked.

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[10] For completeness, the detail of the IDNR 2005 CALPUFF protocol has been incorporated in this document.
[11] Beta at the time of implementation.

Table 5-1. Specification of the version and level of the CALPUFF modeling system processors used by the IDNR.

Processor	Version	Level
TERREL	3.311	030709
CTGCOMP[12]	not used	
CTGPROC	2.42	030709
MAKEGEO	2.22	030709
CALMM5	2.4	050413
CALMET	5.53a	040716
CALPUFF	5.711a	040716
POSTUTIL[13]	1.4	040818
CALPOST	5.51	030709

5.2.2 TERREL

The TERREL processor constructs the basic properties of the gridded domain and subsequently defines the coordinates upon which meteorological data are stored. Key assignments include grid type, location, resolution, and terrain elevation. Grid type is a Lambert Conic Conformal (LCC) projection centered at 97 degrees West longitude, 40 degrees North latitude, with true latitudes of 33 and 45 degrees north. CALMET meteorological processing is computed upon the LCC projection with 171 by 165 horizontal grid cells at 12 km resolution. Computational burden reduction and boundary artifact minimization requires the CALPUFF domain consist of a subset of the CALMET domain. Nine grid cells (108 km) were eliminated along each boundary. Figure 5-1 depicts the horizontal attributes of the CALMET and CALPUFF modeling domains in reference to the 36 km Regional Planning Organizations (RPO) meteorological modeling domain. Table 5-2 provides the LCC specifications for each domain.

Terrain elevation is assigned using 30 second GTOPO data. To ensure comprehensive disclosure of all model configuration options related to TERREL, Appendix 10.1 provides a complete listing of control script variables and their assigned values.

5.2.3 CTGPROC

Land use categories for each grid cell are assigned using CTGPROC. The primary variable adjustment associated with CTGRPOC is selection of an appropriate land use database. Version 1.2 of the North American Land Cover Characteristics database is recommended and a model ready version of this dataset was used.[14] Appendix 10.2 provides further guidance regarding the CTGPROC control file configuration.

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[12] The CTGCOMP processor was not required as the North American landuse file was obtained from the CALPUFF Training Course CD distributed during the CENSARA sponsored CALPUFF training held in Kansas City, November 17-19, 2003.

[13] Obtained from Kirk Baker with the Lake Michigan Air Directors Consortium.

[14] Obtained from the CALPUFF Training Course CD distributed during the CENSARA sponsored CALPUFF training held in Kansas City, November 17-19, 2003.

MM5 RPO Domain; CALMET and CALPUFF 12km Modeling Domains

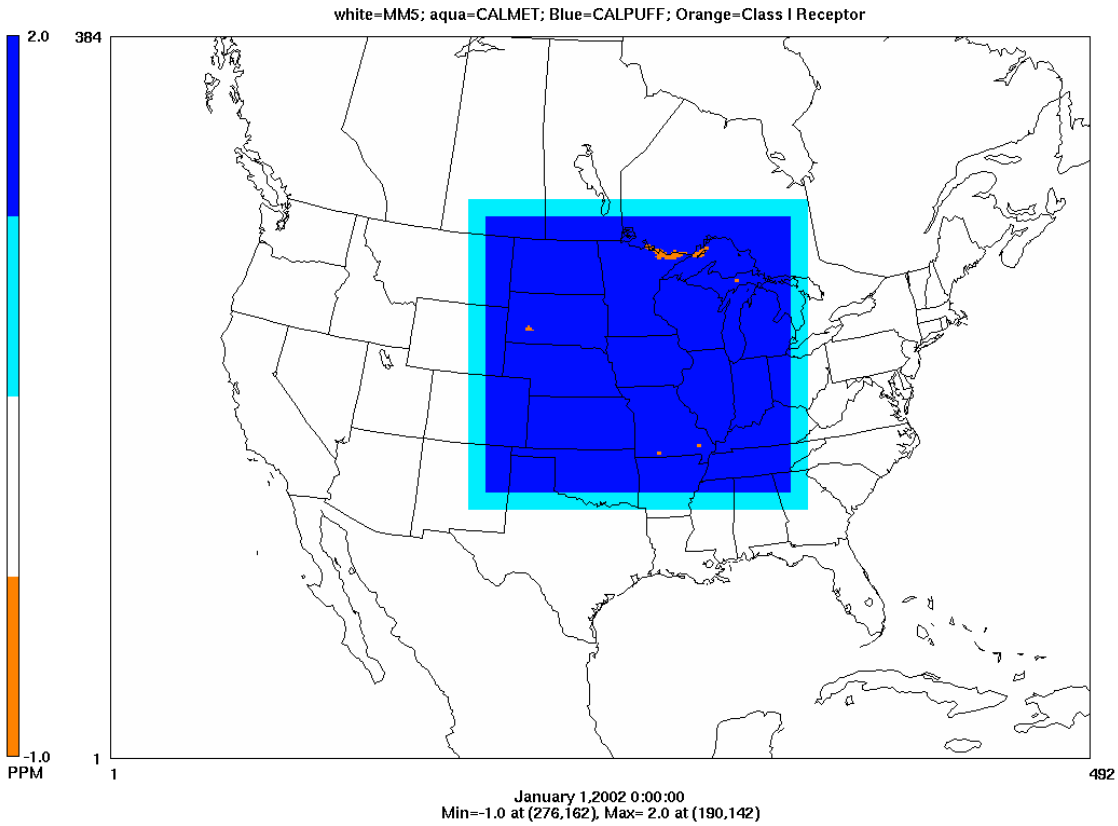

Figure 5-1. The dark blue area depicts the horizontal attributes of the CALPUFF modeling domain. Boundary cells modeled within CALMET and excluded in CALPUFF are indicated in aqua. The background map represents the RPO 36 km MM5 domain. Grid cells which contain a 1 km Class I area receptor (flagged for evaluation) are indicated in orange.

Table 5-2. Lambert Conic Conformal modeling domain specifications. (Referencing MM5 terminology, the coordinate data represent 'dot' points, while the number of grid cells refers to 'cross' points.)

Domain	Southwest Coordinate	Northeast Coordinate	Number of X grid cells	Number of Y Grid Cells	Resolution
MM5	(-2952.0, -2304.0)	(2952.0, 2304.0)	164	128	36 km
CALMET	(-792.0,-720.0)	(1260.0,1260.0)	171	165	12 km
CALPUFF	(-684.0,-612.0)	(1152.0,1152.0)	153	147	12 km

5.2.4 MAKEGEO

As stated in the control file: "MAKEGEO creates the geophysical data file for CALMET. Using the fractional land use data from CTGPROC, it calculates the dominant land use for each cell and computes weighted surface parameters". Generating the appropriate MAKEGEO.INP control file requires only minimal alteration of the default assignments. Key modifications include specifying domain attributes and ensuring input files are correctly referenced. Appendix 10.3 provides complete detail regarding the IDNR control script configuration.

5.2.5 CALMM5

The meteorological data incorporated within the model plant analyses originates with three annual MM5 mesoscale meteorological simulations, covering the years 2002-2004. The 2002 MM5 data was generated by the IDNR, while years 2003 and 2004 were supplied by Kirk Baker with the Lake Mike Michigan Air Directors Consortium (LADCO). The IDNR 2002 dataset has been evaluated by several reviewers (Johnson, 2007; Baker et al., 2004; Baker, 2005; and Kemball-Cook et al., 2005) and was found appropriate for implementation in regional air quality modeling studies. Through independent evaluation, K. Baker has completed a model evaluation of years 2003 & 2004, and found the meteorology to be of the same quality as other datasets currently employed in regional scale one-atmosphere modeling efforts (Baker, 2005).

CALMM5 prepares the MM5 data for CALMET ingestion. Configuration is intuitive as only a minimal number of variables are available for user modification. Two settings are of primary importance: 1) All vertical layers from MM5 were extracted, providing CALMET configuration flexibility. 2) Of the five fields CALMM5 is capable of extracting, four were obtained: vertical velocity, relative humidity, cloud/rain fields, and ice/snow fields. Graupel was not available in the MM5 datasets. Appendix 10.4 contains a representative control file.

5.2.6 CALMET

CALMET configuration begins with the recommendations published in the IWAQM Phase 2 report. The authors of the IWAQM report and EPA recognize a 'cookbook' approach is rarely proper. When deemed appropriate for reasons of scientific validity or for resource constraint issues, the IDNR CALMET configuration differs from the IWAQM settings. Modifications are discussed below. Appendix 10.5 contains a robust comparison between the IDNR configuration and the recommendations from the IWAQM Phase 2 report.

5.2.6.1 METEOROLOGICAL DATA DISCUSSION

Meteorological data sources are the primary point of disparity between the IWAQM recommendations and the IDNR configuration. The IDNR utilized three annual MM5 simulations (2002, 2003, and 2004) as the sole source for CALMET input meteorological data. Blending MM5 and observational data within CALMET was originally viewed as an unnecessary redundancy considering the numerous mesoscale meteorological modeling advances made since publication of the IWAQM Phase 2 report. The Penn State University/National Center for Atmospheric Research Meteorological Model has evolved from MM4 to MM5. MM5 features new land surface models, new/updated physics parameterizations, bug fixes, and is generally configured with higher model resolution, all of which contribute to improved model performance.

Substantial gains in MM5 initialization data quality and four-dimensional data assimilation (FDDA) techniques, through utilization of Eta objective analyses, also surface as key improvements which would appear to diminish the need for additional CALMET processing of National Weather Service (NWS) data. FDDA was applied in each annual MM5 simulation with surface winds and several state variables above the PBL nudged toward observations. Generation of the FDDA datasets requires incorporating the NWS surface and upper air data with the Eta data, a requirement viewed to be redundant by many meteorological modelers as the complexity, resolution, and accuracy of the Eta data exceeds that of traditional initialization sources such as the ECMWF datasets. The Eta data consists of 3-hourly, 40km objective analysis fields computed using an extensive supply of observational data. In addition to the standard NWS surface and upper air data, data sources include: GOES (satellite) precipitable water; VAD wind profiles from NEXRAD; ACARS aircraft temperature data; SSM/I oceanic surface winds; daily NESDIS 23-km snow cover and sea-ice analysis data; RAOB balloon drift; GOES and TOVS-1B radiance data; 2D-VAR sea surface temperature data from the NCEP Ocean Modeling Branch; radar estimated rainfall; and surface rainfall. Obtaining and preparing the NWS data for blending within CALMET was therefore originally viewed as purely extraneous. These assumptions were shown to be incorrect when CALMET performance as a function of meteorological data was investigated by Bret Anderson. B. Anderson (2006) discovered performance issues exist within the CALMET/CALPUFF system if CALMET digests only MM5 data (the 'No-Obs' approach). The preferred alternative reincorporates the NWS observational data into the MM5 solution within the CALMET processor.

The findings were quickly released once discovered; unfortunately the timing remained well past the completion date of the IDNR model plant analyses. Recognizing that reconstruction of all CALPUFF analyses with the preferred approach was not feasible given time and resource constraints, regeneration of the model-plant results was not required. IDNR acknowledges any subsequent CALPUFF analyses will require avoidance of No-Obs. While the CALMET data utilized by IDNR is not an ideal dataset, the model plant approach may reduce the impacts of the errors, as: 1) specific transport pathways are not considered; and 2) the model-plant approach utilizes results from the receptor reporting the greatest impact, co-location within a Class I area is not required.

5.2.6.2 VERTICAL STRUCTURE

The vertical structure of the IDNR CALMET configuration deviates from the IWAQM recommendation to remain consistent with MM5. The IDNR vertical structure was designed to reduce vertical interpolation while simultaneously improving vertical resolution within the planetary boundary layer (PBL). Table 5-3 specifies the 13 layer interfaces defining the IDNR 12 layer vertical structure. With the exception of the interfaces at 20 and 40 meters, all values correspond to an MM5 interface. The model top in the CALMET simulation is 3448 meters, which also corresponds to the maximum mixing height. Given that PBLs regularly exceed 3000 meters over the Dakotas and arid regions in the western third of the IDNR CALMET domain, the PBL increase is appropriate.

Table 5-3. Vertical resolution as defined through 13 layer interfaces. Heights are in meters.

Layer number	Layer Height	Layer number	Layer Height
0	0.	7	1071.
1	20.	8	1569.
2	40.	9	2095.
3	73.	10	2462.
4	146.	11	2942.
5	369.	12	3448.
6	598.		

5.2.6.3 PARAMETERIZATIONS

Kinematic terrain effects were enabled in response to the interpolation between the 36 km MM5 and 12 km CALMET domains. Higher resolution is not being sought as: 1) the lack of topological features within and near the State of Iowa does not warrant the additional processing; and 2) interpolation of 36 km meteorological fields to a resolution finer than 12 km raises conceptual concerns. While terrain features further downwind and within specific Class I areas may differ from Iowa's relatively flat topology, given extensive transport distances, a realistic expectation of pollutant transport includes sufficient mixing and shear across the plume such that low concentration gradients occur around candidate Class I areas, subsequently reducing the impacts of downwind topology. In addition, application of CALPUFF in the model plant configuration eliminates the evaluation of plume concentrations at specific Class I area receptors. A more conservative approach is taken as the analysis focuses only upon maximum impacts, with no preference to receptor location. This methodology is discussed further under the CALPUFF configuration section (5.2.7).

5.2.6.4 REMAINING ASYMETRIES

The following bullets summarize the residual differences between the IDNR and IWAQM recommended CALMET configurations.

- Gridded cloud data is being inferred from the MM5 relative humidity fields, a process not invoked in IWAQM. As discovered by Anderson (2006), when incorporated with the No-Obs approach, this methodology leads to simulation error. However, EPA Region VII is not requiring regeneration of the CALMET fields to correct this methodology given discovery date and project timelines.
- Given that all state variables are MM5-derived, surface layer winds were not extrapolated to the upper layers (the IDR configuration uses IEXTRP = -1), whereas the IWAQM recommends similarity theory in surface layer wind extrapolation.
- The radius of influence regarding terrain features is equidistant to the resolution of the processed terrain data: 12 km.
- The radius of influence for temperature interpolation is set to 36 km (TRADKM), a value considered appropriate given the 12 km CALMET domain and 36 km MM5 domain.
- The beginning/ending land use categories for temperature interpolation over water are assigned category 55: (JWAT1 = JWAT2 = 55).

- SIGMAP was set to 50 km, while the IWAQM recommendation is 100 km. However, as precipitation rates are incorporated from the MM5 data, a lower radius of influence is deemed appropriate by the IDNR.
- Note, while the BIAS array equals NZ*0 in the IDNR control file, CALMET reassigns BIAS(1) = -1 (i.e. upper air data not used in layer 1); and BIAS(2) = +1 (i.e. the surface data is not extrapolated vertically).
- The MM5 wind fields supply CALMET with the initial guess fields to the diagnostic wind model (IWFCOD =1, IPROG = 14) and observational data are not reintroduced. The following variables therefore have no impact upon the simulation and are provided solely for completeness:
    - The minimum distance for which extrapolation of surface winds should occur is set to -1 (RMIN2 = -1.).
    - RMIN is left at the IWAQM recommendation of 0.1 km.
    - RMAX1 and RMAX2 are each assigned a value of 30 km. RMAX3 is assigned a value of 50 km.
    - R1 and R2 were each assigned the value of 1.0.
    - ISURFT and IUPT are assigned placeholder values of 4 and 2, respectively.

5.2.7 CALPUFF

Unlike traditional CALPUFF implementations which rely upon receptors confined to Class I areas, the model plant analysis evaluates impacts independent from Class I area location. Discrete receptors are located at evenly spaced intervals equidistant from the model plant. Visually, the receptors comprise a ring around the plant. Only two variables are required to define the ring, distance from the stack to the ring (radius) and the spacing of the receptors relative to one another. In defining the IDNR receptors, Figure 3-2 was consulted. A radius of 425 km was selected, as this value maintains some conservatism by avoiding the trough of the curve (where impacts are minimized) while simultaneously avoiding distances (above ~450 km) where impacts are highly suspect. To ensure thorough receptor density at this distance, one degree separation was chosen, yielding 360 receptors per simulation. In terms of the visibility contribution analysis, the model plant configuration assumes each receptor to be located in a Class I area, and the receptor reporting the highest impact is utilized.

The initial CALPUFF configuration resembles the recommendations of the Phase 2 IWAQM report, as related to refined (versus screening) analyses. While Section 2.0 of the IWAQM documentation recommends using time and space varying ozone concentrations, IDNR methods deviate. As the application of CALPUFF is occurring within a model plant framework, receptor location is not critical thus no real advantage is gained through the application of prognostic models to develop spatially dependent pollutant concentration fields. Similarly, retrieval of ozone monitoring network data is not viewed as advantageous as observing stations trend toward urban centers and thus are not representative of the conditions found in the predominantly rural IDNR domain. As an alternative, background ozone concentrations of 40 ppb are prescribed across the modeling domain. An analysis of ozone data collected at Lake Seguma, IA, for the 2003[15] ozone modeling season, supports this conclusion. The monthly averages of the one-hour ozone concentrations at Lake Seguma ranged from 21 to 39 ppb. Forty ppb is selected as an

[15] 2003 data was analyzed as a complete year of NH3 data was available, and utilizing co-located (time and space) NH3 and ozone data was viewed as advantageous.

accurate, yet slightly conservative value, as the seasonal average was found to be 31 ppb. Analysis of the NH3 data collected at Lake Seguma yielded an annual average concentration of 3 ppb. Incorporation of monthly varying NH3 concentrations was considered; however, as the version of CALPOST utilized does not take such variation into consideration, the default NH3 background concentration was assigned as 3 ppb. Appendix 10.6 contains a robust comparison between the IDNR configuration and the recommendations from the IWAQM Phase 2 report, variations are described below.

Configuration options and notable exceptions are included below:

- Puff splitting was enabled, with NSPLIT=2 (the default NSPLIT value of 3 is computationally prohibitive). Puffs are allowed to split once per day, at hour 17. Puff splitting was enabled for years 2002 and 2004. Puff splitting was excluded from the 2003 simulation as run times approached day per day (real-time) requirements at the mid-point of the simulation (*e.g.* the 2003 annual CALPUFF simulation was estimated to require 160 days[16] to complete).
- No subgrid scale complex terrain options were activated.
- The modeled (and output) species include the following six compounds: SO2, SO4, NOx, HNO3, NO3, primary PM.
- Three species were emitted, NOx, SO2, and primary PM. All primary PM is assumed to be PM2.5. This assumption is prescribed through assignment of geometric mass mean diameter and geometric standard deviation as 0.48 and 2.0 microns, respectively (see Table 5-4 below).
- Building downwash parameters were not applicable, as downwash was not modeled.
- Boundary conditions were not modeled (MBCON = 0) (boundary conditions are not mentioned in the IWAQM report).
- FOG model output was not enabled (MFOG =0) (this parameter was not mentioned in the IWAQM report).
- Output units were in terms of ug/m**3, versus the IWAQM setting of g/m**3.
- New to CALPUFF is an aqueous phase transformation flag, however, this option was not enabled (MAQCHEM=0).
- The IWAQM report provides only one value (0.01) for CDIV (the divergence criterion for dw/dz). The version utilized provides a two dimensional array for CDIV values. Default values were 0.0 & 0.0 and were not altered.
- Model plant stack parameters mirrored the values provided in the *CALPUFF Analysis in support of the June 2005 Changes to the Regional Haze Rule* (EPA, 2005b). Specifically, the following Industrial Boiler stack parameters were defined: stack height of 55 meters, stack diameter of 2.6 meters, exit velocity of 11.4 m/s, and an exit temperature of 414 K. Stack location was defined near the center of Iowa with a base elevation of 333.5 meters. The industrial boiler was selected as Iowa EGU sources satisfy most BART requirements through participation in the CAIR cap and trade program.

[16] Run times for years 2002 and 2004 were a more reasonable 30 hours per simulation. The cause of the run time disparity was not investigated due to resource constraint issues and a lack of anomalous results when puff-splitting was disabled.

- Tables 5-4 through 5-6 detail the size parameters for the dry deposition of particles, dry deposition parameters for gases, and the wet deposition parameters, respectively. Values were based upon the defaults when available.

Table 5-4. Dry deposition particle size parameters.

Species Name	Geometric Mass Mean Diameter (microns)	Geometric Standard Deviation (microns)
SO4	0.48	2.0
NO3	0.48	2.0
Particulate	0.48	2.0

Table 5-5. Dry deposition parameters.

Species Name	Diffusivity (cm**2/s)	Alpha Star	Reactivity	Mesophyll Resistance (s/cm)	Henry's Law Coefficient
SO2	0.1509	1000.	8.	0.	0.04
NOx	0.1656	1.	8.	5.	3.5
HNO3	0.1628	1.	18.	0.	0.00000008

Table 5-6. Wet deposition parameters.

Species Name	Liquid Precipitation Scavenging Coefficient	Frozen Precipitation Scavenging Coefficient
SO2	3.0E-5	0.0E0
SO4	1.0E-4	3.0E-5
NOx	0.00E0	0.0E0
HNO3	6.0E-4	0.0E0
NO3	1.0E-4	3.0E-5
Particulate	1.0E-4	3.0E-5

5.2.8 POSTUTIL

Generation of an appropriate POSTUTIL configuration file is straightforward. Of critical importance is the version selected for implementation. Neither the Beta nor regulatory versions available through the CALPUFF website are utilized, due to run-time errors encountered. Alternatively, version 1.4 Level 040818 was selected. Establishment of the appropriate control file requires the following modifications:

- The modeled (and output) species list includes the following six species: SO2, SO4, NOx, HNO3, NO3, primary PM.
- Simplification of the modeling process occurs through independent execution of each annual simulation. Subsequently, as in CALPUFF and CALMET, modification of the control file to prescribe either calendar year 2002, 2003, or 2004, is required.

- The background NH_3 concentration is set at 3 ppb, in order to remain consistent with the CALPUFF configuration.

Appendix 10.7 provides appropriate definition for all POSTUTIL variables.

5.2.9 CALPOST

The CALPOST processor is capable of producing a variety of analyses and care must be taken to ensure results are consistent with EPA recommendations. Visibility assessment Method 6 most closely mirrors EPA guidelines. A feature of Method 6 is the need for Class I area specific *f(RH)* (relative humidity adjustment factors) and natural background conditions. Selection of Class I area data for evaluation is therefore required, even with the model plant approach. The following Class I areas were flagged for evaluation based upon their distance from Iowa sources:

- Badlands, South Dakota
- Boundary Waters Canoe Area, Minnesota
- Mingo & Hercules-Glades, Missouri

Incremental probability statistical analyses (IDNR, 2002) suggest the need for inclusion of additional sources to the north and northeast of Iowa, hence evaluation of visibility impacts for Isle Royale (MI), Seney (MI), and Voyageurs (MN) is completed. These Class I areas are commonly abbreviated as in Table 5-7.

Table 5-7. Class I area abbreviations.

Class I Area and State	Common Abbreviation
Badlands, SD	BADL
Voyageurs, MN	VOYA
Boundary Waters Canoe Area, MN	BOWA
Isle-Royale, MI	ISRO
Seney, MI	SENE
Mingo, MO	MING
Hercules-Glades, MO	HEGL

Natural background concentration and *f(RH)* data were extracted from EPA's *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program* (2003). The site specific *f(RH)* values are listed in Table 5-8. Table 5-9 provides the species concentrations representing annual average natural background conditions. Annual average natural background concentrations are not strictly Class I area specific. Alternatively, sites are assigned one of two datasets: Eastern or Western. Of the seven Class I areas examined within the Iowa domain, all are considered Eastern sites with the exception of the Badlands.

Table 5-8. Class I area specific monthly averaged and the annually average f(RH) data. These data are based upon the Class I area centroid. The centroid data are considered more appropriate than IMPROVE monitor data as IMPROVE monitor siting locations may exist outside park boundaries.

Class I Area	Monthly *f(RH)* data: Jan – Dec	Avg.
Badlands, SD	2.6, 2.7, 2.6, 2.4, 2.8, 2.7, 2.5, 2.4, 2.2, 2.3, 2.7, 2.7	2.55
Voyageurs, MN	2.8, 2.4, 2.4, 2.3, 2.3, 3.1, 2.7, 3.0, 3.2, 2.6, 2.9, 2.8	2.71
Boundary Waters Canoe Area, MN	3.0, 2.6, 2.7, 2.4, 2.3, 2.9, 3.1, 3.4, 3.5, 2.8, 3.2, 3.2	2.93
Isle-Royale, MI	3.1, 2.5, 2.7, 2.4, 2.2, 2.6, 3.0, 3.2, 3.8, 2.7, 3.3, 3.3	2.90
Seney, MI	3.3, 2.8, 2.9, 2.7, 2.6, 3.1, 3.6, 4.0, 4.1, 3.4, 3.6, 3.5	3.30
Mingo, MO	3.3, 3.0, 2.8, 2.6, 3.0, 3.2, 3.3, 3.5, 3.5, 3.1, 3.1, 3.3	3.14
Hercules-Glades, MO	3.2, 2.9, 2.7, 2.7, 3.3, 3.3, 3.3, 3.3, 3.4, 3.1, 3.1, 3.3	3.13

Table 5-9. Annual Average natural background concentrations (ug/m3) for Eastern and Western U.S. Class I Sites. Data define annually averaged natural background conditions.

	Eastern	Western
$(NH_4)_2SO_4$	0.23	0.12
NH_4NO_3	0.10	0.10
OC	1.40	0.47
EC	0.02	0.02
SOIL	0.50	0.50
CM	3.00	3.00

Initial evaluation involved natural background as based upon annually averaged conditions. At the request of EPA Region VII, the 20% best natural background conditions are also examined. While results based upon the 20% best natural background conditions will be provided, annual average natural background conditions will also be considered in the subject to BART determination process. These methods are consistent with the UARG Settlement Agreement which provided further clarification regarding natural background conditions, allowing State discretion in selection of natural background conditions in terms of 20% best days or annual averages.

Standard CALPOST configuration requires that natural background conditions be represented as speciated concentration data. No such data exists for the 20 percent best natural background conditions. These conditions are described only through Class I area specific deciview values. The deciview values must therefore be converted into speciated concentrations. Procedures described in the draft North Dakota protocol (North Dakota Department of Public Health, 2005) were followed to scale the annual concentration data to the 20 percent best natural background conditions. An example of the scaling methods follows.

The IMPROVE equation (5.1) is coupled with the following Class I area specific data: the annually averaged natural background concentrations; the annually averaged *f(RH)* value; and the deciview value representing the 20% best natural background visibility conditions. For example, visibility degradation at Boundary Waters Canoe Area (BOWA) for the 20% best natural background conditions is described as 3.53 dv (EPA, 2003). This value is converted to an extinction coefficient, via Eq. 5.2, yielding 14.23 Mm^{-1}. Incorporating the annually averaged *f(RH)* value (2.93 for BOWA) from Table 5-8 and the natural background concentrations from Table 5-9 (using Eastern site data), Eq. 5.3 is solved for the BOWA specific scaling factor: [X]. The scaling factor (in this example, 0.385) is then applied equally to the speciated annually averaged natural background concentrations to arrive at the BOWA 20 percent best conditions. Repeating the calculations for each Class I area yields the results provided in Table 5-10.

$$B_{ext} = 3 \cdot f(RH) \cdot \left[(NH_4)_2 SO_4 \right] + 3 \cdot f(RH) \cdot \left[NH_4 NO_3 \right] + 4 \cdot [OC] + 10 \cdot [EC] + 1 \cdot [SOIL] + 0.6 \cdot [CM] + B_{Rayleigh} \qquad \textit{Eq. 5.1}$$

$$B_{ext} = 10 \cdot e^{(dv/10)} \qquad \textit{Eq. 5.2}$$

$$14.23 = 3 \cdot 2.93 \cdot [0.12] \cdot [X] + 3 \cdot 2.93 \cdot \left[0.10 \right] \cdot [X] + 4 \cdot [1.40] \cdot [X] + 10 \cdot [0.02] \cdot [X] + 1 \cdot [0.5] \cdot [X] + 0.6 \cdot [3.0] \cdot [X] + 10 \qquad \textit{Eq. 5.3}$$

Table 5-10. Site specific speciated data associated with calculation of natural background conditions on the 20 percent best days.

			20% Best Natural Background						
			Deciviews (B_{ext})[a]	Scaled Concentrations (ug/m3)					
Site	***f(RH)***	**Scaling Factor [X]**		**SO_4**	**NO_3**	**OC**	**EC**	**SOIL**	**CM**
BADL	2.55	0.402	2.18 (12.44)	0.048	0.040	0.189	0.008	0.201	1.207
BOWA	2.93	0.385	3.53 (14.23)	0.088	0.038	0.538	0.008	0.192	1.154
HEGL	3.13	0.386	3.59 (14.32)	0.089	0.039	0.540	0.008	0.193	1.157
ISRO	2.90	0.387	3.54 (14.25)	0.089	0.039	0.542	0.008	0.194	1.162
MING	3.14	0.385	3.59 (14.32)	0.089	0.039	0.540	0.008	0.193	1.156
SENE	3.30	0.392	3.69 (14.46)	0.090	0.039	0.549	0.008	0.196	1.177
VOYA	2.71	0.377	3.41 (14.06)	0.087	0.038	0.527	0.008	0.188	1.130

[a] Deciview values are listed first and the data in parenthesis are the corresponding B_{ext} values calculated using Eq. 5.2.

As CALPOST requires execution for each Class I area, 14 configuration files were produced. Seven assign annually averaged natural background conditions while the remainders assign the 20% best natural background conditions. Control file differences exist only in the site specific *f(RH)* and natural background concentration values. Regarding the calculation of visibility metrics, sulfate, nitrate, and primary PM (modeled in the fine mode) are included. Rayleigh scattering is set to 10 inverse megameters. Appendix 10.8 provides a complete listing of variable assignments.

5.3 RESULTS

Each model plant simulation requires 14 iterations of the CALPOST processor: two natural background scenarios across seven Class I areas. Results for each Class I area assessment are tabulated and ranked individually. Both maximum and 98th percentile values are considered when determining the levels at which emissions may cause (deciview impacts greater than or equal to 1.0) or contribute (deciview impacts greater than or equal to 0.5) to visibility impairment.

Figures 5-2 through 5-4 depict twelve critical model plant analyses. Figure 5-2 data are confined to calendar year 2002. Figure 5-3 and Figure 5-4 summarize years 2003 and 2004, respectively. For each year results are arranged in a four-panel configuration according to the following: the upper figures use the emission scenario where the model plant emits 2500 tpy of SO2, 2500 tpy of NOx, and 50 tpy of PM2.5. The lower figures utilize the model plant configured with emissions of 1500 tpy of SO2 and NOx each, and 50 tpy of PM2.5. In the left hand figures, impacts are compared against annually averaged natural background conditions. The right hand figures compare visibility impacts against the 20 percent best natural background conditions.

Individual plots within the four panel arrangement follow the same template. The bar charts display a count of the number of days in which deciview impacts greater than or equal to 0.5 are produced (labeled on the left hand y-axis). If the 98th percentile is considered, a maximum of 7 days with deciview impacts exceeding 0.5 are permitted, depicted by the solid red line (to remain within the 98th percentile the bar charts must remain at or below this line). Maximum deciview impacts are also reported (labeled on the right hand y-axis and indicated using a character similar to the asterisk). The solid blue line denotes the 0.5 dv impact level. Within each plot, results for each of the seven Class I areas are provided.

The results presented in Figures 5-2 through 5-4 illustrate that the model plant, with 5000 tpy of NOx & SO2 combined (and 50 tpy of PM2.5), does not yield any deciview impacts greater than 0.5 dv at the 98th percentile as compared against annually averaged natural background conditions. In years 2002 and 2003, a maximum of 5 days exceed the 0.5 dv impact threshold, occurring at the Badlands, likely due to utilization of the cleaner Western natural background conditions. During 2004, the count increases to 6. The remaining six Class I area evaluations yield counts less than or equal to 5. Considering individual daily maximum impacts, 2002 values remain near the 0.5 dv level, slightly higher maximum impacts occur in 2003. 2004 shows maximum impacts consistently above 1.0 dv. The situation changes dramatically when compared against the 20 percent best natural background conditions, where in each year, for each site, greater than 7 days are found with maximum impacts exceeding 0.5 dv. As expected, maximum individual daily impacts show a corresponding increase versus annually averaged natural background conditions.

Turning to the model plant scenario with emissions of 3000 tpy SO2+NOx and 50 tpy PM2.5, the 98th percentile is never exceeded, regardless of the natural background scenario. Additionally, at 3000 tpy SO2+NOx, maximum impacts for years 2002 and 2003, as compared against annually averaged natural background conditions, do not exceed 0.5 dv. Year 2004 does produce impacts above 0.5 dv. Two days above 0.5 dv are modeled for the Badlands, and one day above 0.5 dv are shown for the remaining Class I areas.

Consulting the 20% best natural background conditions, maximum daily impacts remain below 0.5 dv for all but Seney in 2002. In 2003, impacts greater than 0.5 dv are found for each site, but occur on no more than 2 days. Again, 2004 stands out as producing the highest impacts, but the impacts do not exceed the 98th percentile.

Based upon the above results, the IDNR concludes that any BART-eligible source which emits less than 3000 tpy of combined NOx, SO2 and PM will likely be exempt from a subject to BART declaration. At the 3000 tpy level, evaluation against the stringent 20% best natural background conditions yields no more than 5 days with deciview impacts exceeding 0.5 dv, thus surpassing the 98th percentile benchmark. Consulting Table 4-1, it can be shown that 11 of the 14 non-EGU BART-eligible sources remain well below the 3000 tpy combined potential to emit. These are the same facilities identified in Table 4-3.

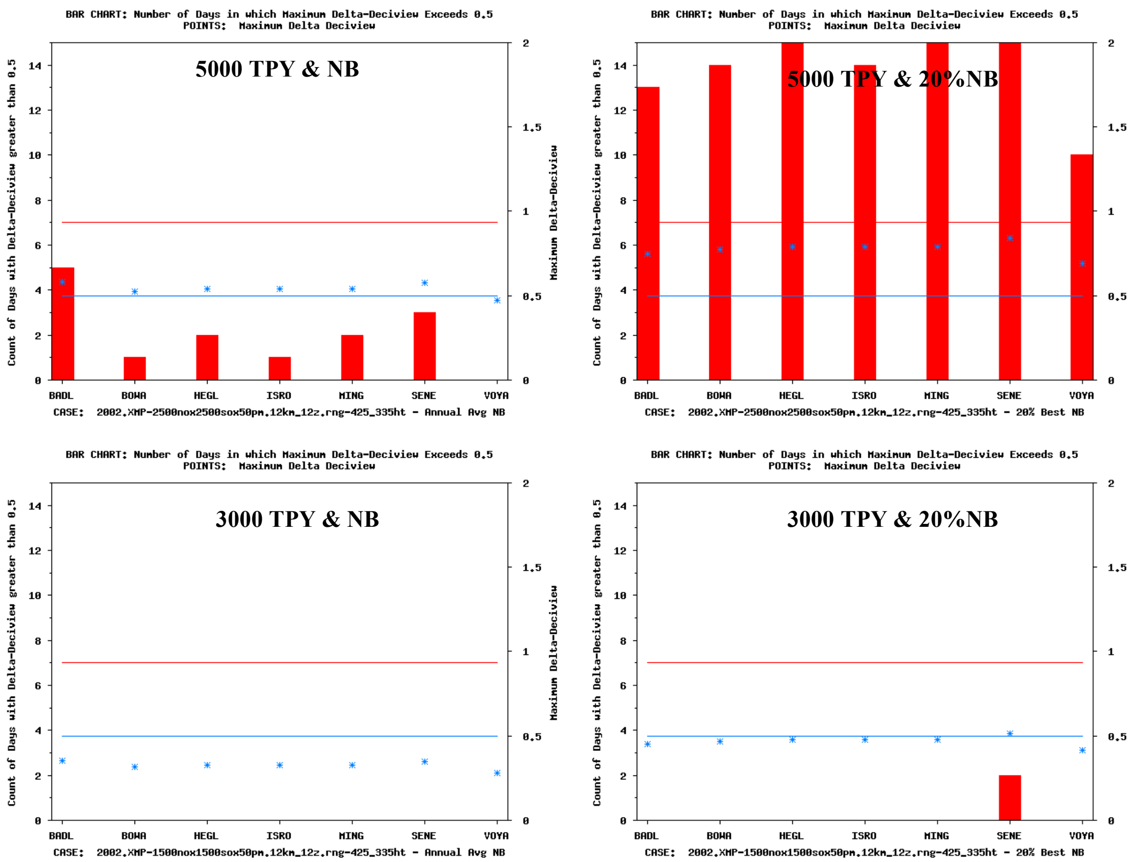

Figure 5-2. Deciview impacts from four Iowa model plant configurations: results for year 2002 with combined SO2 and NOx emissions of 5000 and 3000 tpy, as compared against annually averaged natural background (NB) conditions and 20% best NB conditions.

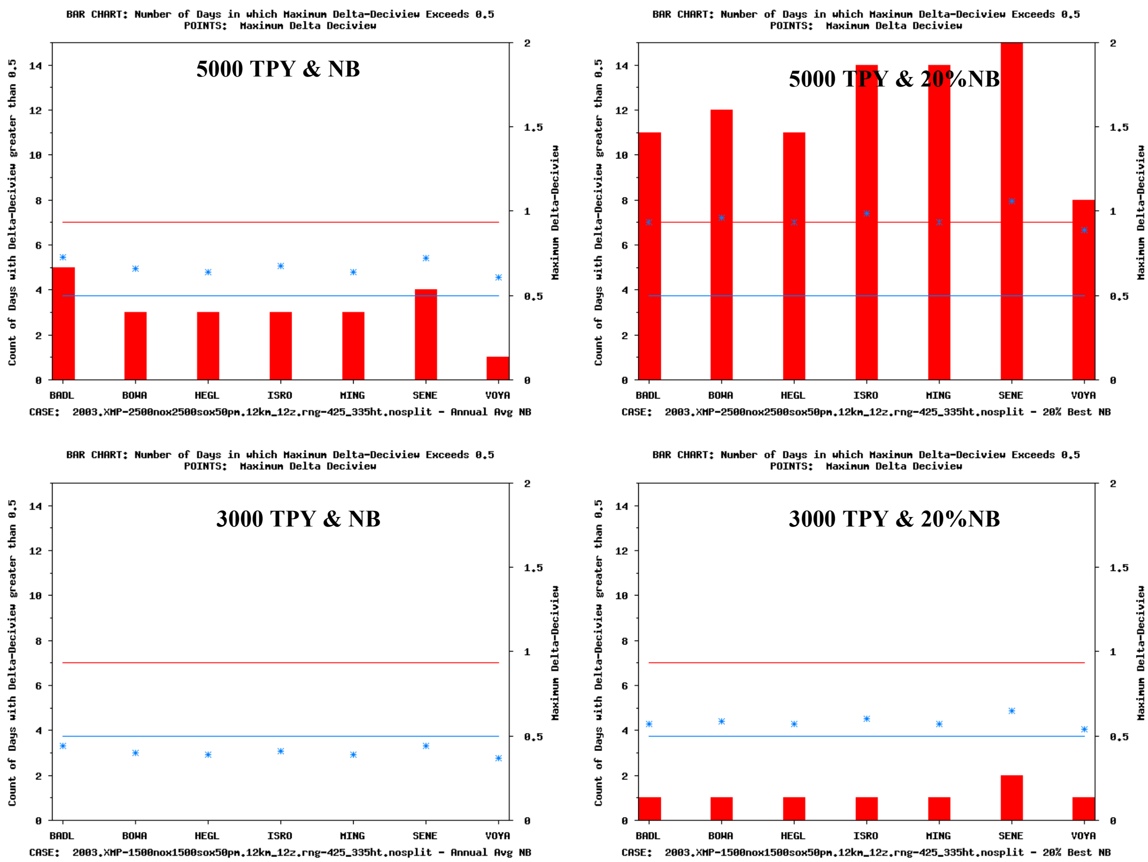

Figure 5-3. Deciview impacts from four Iowa model plant configurations: results for year 2003 with combined SO2 and NOx emissions of 5000 and 3000 tpy, as compared against annually averaged natural background (NB) conditions and 20% best NB conditions. Puff splitting was not enabled for this year, due to computational burden.

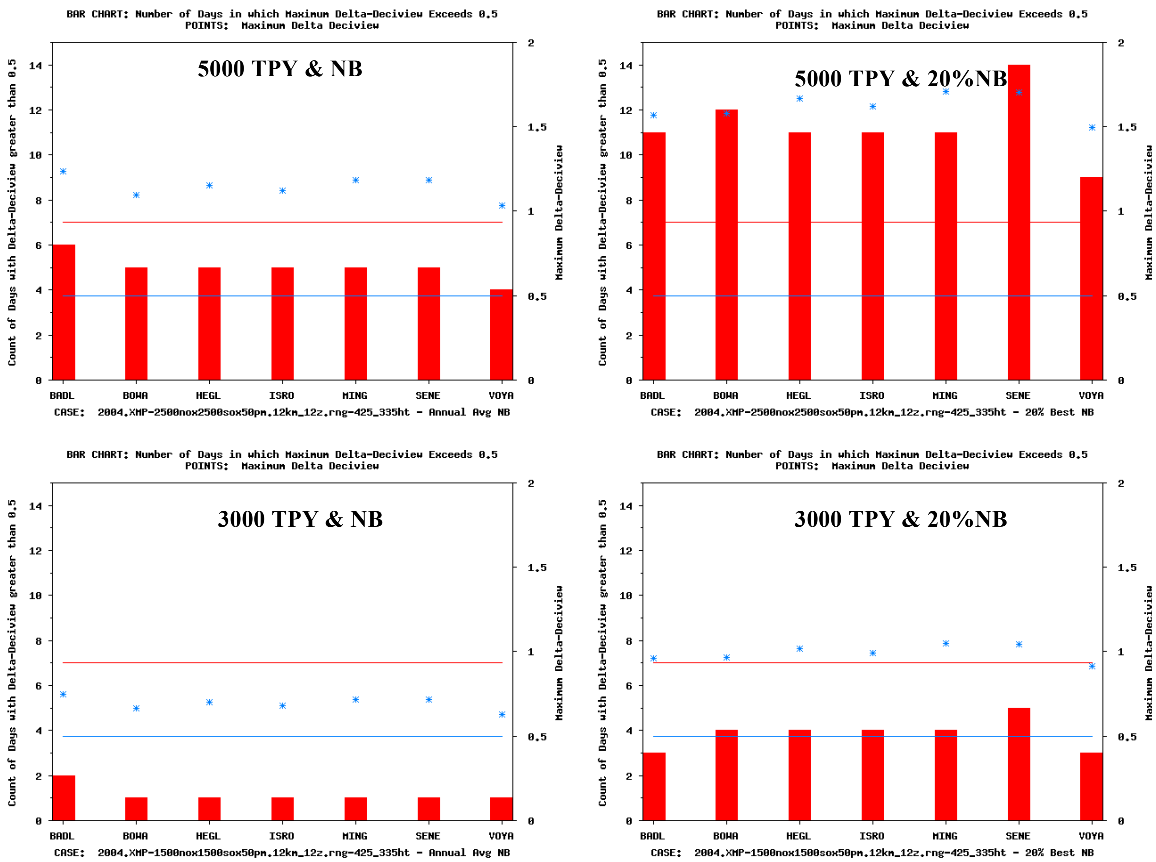

Figure 5-4. Deciview impacts from four Iowa model plant configurations: results for year 2004 with combined SO2 and NOx emissions of 5000 and 3000 tpy, as compared against annually averaged natural background (NB) conditions and 20% best NB conditions.

6. ALTERNATIVE MODELING

6.1 CONFIGURATION

The IDNR is utilizing the Comprehensive Air quality Model with extensions (CAMx) modeling system in a framework for determining which sources may cause or contribute to visibility impairment at nearby Class I areas. The objective is to model cumulative impacts across all BART-eligible sources. Calendar year 2002 serves as the base year due to the availability of model ready emission inventories and the associated baseline established by one-atmosphere modeling efforts under the regional haze rule. The 36 km (LADCO 4_RPO) domain provides the fundamental horizontal structure. The impacts of a finer resolution 12 km grid will also be assessed. Figure 6-1 depicts both the 36 and 12 km air quality modeling domains.

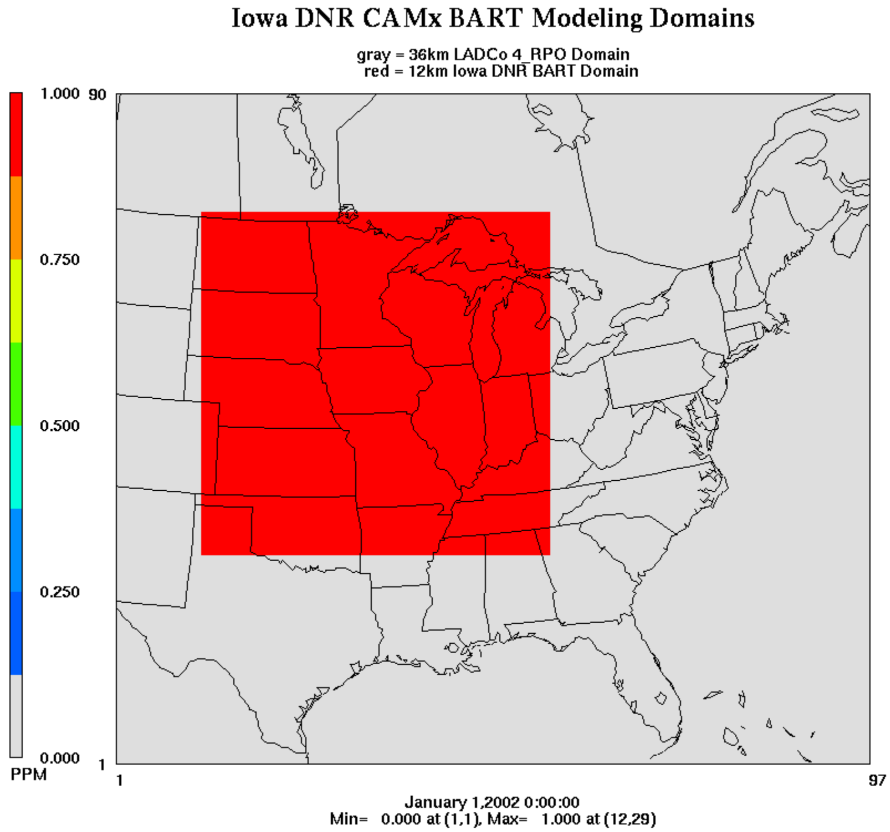

Figure 6-1. The 36 and 12 km modeling domains employed within the CAMx framework for BART modeling.

The meteorological data driving the CAMx system is derived from the IDNR 2002 MM5v363 36/12 km simulation. Performance evaluations of the dataset have been documented by Johnson, 2007; Baker et al., 2004; Baker, 2005; and Kemball-Cook et al., 2005. Reviewers found the dataset well suited to air quality modeling applications. Consequently, the 36 km meteorological dataset is in wide use within the regional modeling community, including use by LADCO, CENRAP, individual states, and private organizations. The 12 km dataset has also been used by

LADCO, IDNR, and the Five-States Modeling Study Project workgroup. Through the results detailed in the referenced reviews, as well as the propensity of the dataset in current studies, IDNR concludes that the meteorological model performance is suitable for use in alternative modeling approaches to BART.

IDNR application of the CAMx modeling system uses the LADCO 2002 BaseJ and BaseK emissions inventories. At project onset BaseJ established the current LADCO inventory, however, during project implementation BaseK was released. Both inventories are the products of multi-year iterative improvement processes and include the most recent 2002 NEI point source inventory. Updates between BaseJ and BaseK emission inventories include motor vehicle emission updates, revised area ammonia and EGU temporal profiles, updated Canadian emissions, and improved non-road emissions (LADCO, 2006). The BaseK modeling system also includes updates to the CAMx source code. Due to the enhancements associated with the BaseK emission inventory and model source code, BaseK is considered technically superior to BaseJ.

Based upon CAMx model performance, in conjunction with review of the emissions inventory and meteorological datasets driving the photochemical grid model, the CAMx (version 4.30) BaseK configuration is viewed to be an appropriate platform for alternative modeling approaches to BART. Initial exploratory cumulative modeling scenarios were completed using BaseJ. Scenarios critical to subject to BART determinations were refined and evaluated using BaseK. BaseK performance evaluations conducted by Kirk Baker (2006) reveal simulation performance commensurate with the current works of other RPOs. In reference to the subject to BART determination, where underprediction may falsely exempt a potential BART source, most species, when biased, were positively biased. Notable exceptions include organic carbon species which were predominantly underpredicted. BaseK results also show a slightly negative bias towards July sulfate concentrations, and late spring/summer nitrate. Mean bias values remained above approximately -0.5 ug/m3. Such error is well within regional modeling expectations and is considered acceptable.

6.2 EVALUATION

Results from the CAMx simulations were evaluated through implementation of IDNR developed software designed to calculate delta-deciview[17] (ddv) metrics. The process begins through calculation of the 24-hour averaged speciated concentrations, followed by conversion into extinction coefficients using the original IMPROVE methods (see Eqs. 6.1 - 6.8). Rayleigh scattering and speciated extinction coefficients are summed to arrive at total extinction (B_{TOT}).

[17] The delta-deciview terminology is purely semantic and merely reinforces the fact that visibility impacts are measured in terms of a difference, for example, as compared against natural background conditions. The 'delta-deciview' is interchangeable with the 'deciview impact' terminology used in describing the CALPUFF results in Chapter 5.

$$B_{TOT} = b_{SO4} + b_{NO3} + b_{OC} + b_{EC} + b_{soil} + b_{coarse} + b_{ray} \quad \text{(Eq. 6.1)}$$

$$b_{SO4} = 3 \cdot f(RH) \cdot [(NH_4)_2SO_4] \quad \text{(Eq. 6.2)}$$
$$b_{NO3} = 3 \cdot f(RH) \cdot [NH_4NO_3] \quad \text{(Eq. 6.3)}$$
$$b_{OC} = 4 \cdot [OMC] \quad \text{(Eq. 6.4)}$$
$$b_{EC} = 10 \cdot [EC] \quad \text{(Eq. 6.5)}$$
$$b_{soil} = 1 \cdot [Soil] \quad \text{(Eq. 6.6)}$$
$$b_{coarse} = 0.6 \cdot [\text{Coarse Mass}] \quad \text{(Eq. 6.7)}$$
$$b_{ray} = 10\ Mm^{-1} \quad \text{(Eq. 6.8)}$$

The mapping of CAMx to IMPROVE species is provided in Eqs. 6.9 - 6.14. CAMx SO4 and NO3 concentrations are ionic and are assumed to be completely neutralized by ammonium (NH4). Full ammonium neutralization is assumed in the IMPROVE methods.

$$[(NH_4)_2SO_4] = 1.375 \times PSO4 \quad \text{(Eq. 6.9)}$$
$$[NH_4NO_3] = 1.290 \times PNO3 \quad \text{(Eq. 6.10)}$$
$$[OC] = POA + SOA1 + SOA2 + SOA3 + SOA4 + SOA5 \quad \text{(Eq. 6.11)}$$
$$[EC] = PEC \quad \text{(Eq. 6.12)}$$
$$[Soil] = FPRM + FCRS \quad \text{(Eq. 6.13)}$$
$$[\text{Coarse Mass}] = CPRM + CCRS \quad \text{(Eq. 6.14)}$$

Two calculation pathways were coded to obtain two delta-deciview metrics. In the first method, Eq. 6.15 (in combination with Eqs. 6.1 - 6.14) is used to calculate a simple delta-deciview between any given scenario and the basecase simulation. Conceptually, this comparison quantitatively describes the visibility impairment, as compared against current (2002) conditions, attributable to those sources whose emissions were modified. This measure is not indicative of a comparison against natural background conditions and was included in the software as a matter of convenience.

$$\Delta dv = 10 \cdot \ln\left(\frac{B_{TOT\_basecase}}{10}\right) - 10 \cdot \ln\left(\frac{B_{TOT\_scenario}}{10}\right) \quad \text{(Eq. 6.15)}$$

The second metric is designed to mirror the methods established in EPA's BART modeling guidance (EPA, 2005a) and the Federal Land Managers Air Quality Related Values Workgroup report (FLAG, 2000) and therefore calculates the visibility impacts of sources as compared against natural background conditions. The procedure requires calculating the differences in the 24-hour averaged speciated concentrations between the basecase and scenario simulations, and then converting these differences to extinction coefficients (see Eqs. 6.16 – 6.21). The speciated extinction impacts are then summed (Eq. 6.22). The value B_{TOT_diff} thus represents the change in total extinction attributable to those sources modified in a given scenario. Through Equation 6.23, a delta-deciview which assesses visibility impacts against natural background conditions can then be calculated. The natural background total extinction (B_{TOT_NB}) is calculated according to the original IMPROVE equation (referencing Eq. 5.1, $B_{TOT\_NB} = B_{ext}$) using the speciated natural background concentrations from Table 5-9 and the monthly averaged Class I area specific *f(RH)* values in Table 5-8. B_{TOT_NB} can also be calculated in terms of the 20 percent best natural background conditions using the *f(RH)* data from Table 5-8 and the speciated concentration data from Table 5-10.

$$b_{SO4_{diff}} = 3 \cdot f(rh) \cdot 1.375 \cdot \left([SO_4]_{basecase} - [SO_4]_{scenario} \right) \quad \text{(Eq. 6.16)}$$

$$b_{NO3_{diff}} = 3 \cdot f(rh) \cdot 1.290 \cdot \left([NO_3]_{basecase} - [NO_3]_{scenario} \right) \quad \text{(Eq. 6.17)}$$

$$b_{OMC_{diff}} = 4 \cdot \left([OMC]_{basecase} - [OMC]_{scenario} \right) \quad \text{(Eq. 6.18)}$$

$$b_{EC_{diff}} = 10 \cdot \left(EC]_{basecase} - [EC]_{scenario} \right) \quad \text{(Eq. 6.19)}$$

$$b_{SOIL_{diff}} = 1 \cdot \left([SOIL]_{basecase} - [SOIL]_{scenario} \right) \quad \text{(Eq. 6.10)}$$

$$b_{CM_{diff}} = 0.6 \cdot \left(CM]_{basecase} - [CM]_{scenario} \right) \quad \text{(Eq. 6.21)}$$

$$B_{TOT\_diff} = b_{SO4_{diff}} + b_{NO3_{diff}} + b_{OMC_{diff}} + b_{EC_{diff}} + b_{SOIL_{diff}} + b_{CM_{diff}} \quad \text{(Eq. 6.22)}$$

$$\Delta dv = 10 \cdot \ln\left(\frac{B_{TOT\_diff} + B_{TOT\_NB}}{B_{TOT\_NB}} \right) \quad \text{(Eq. 6.23)}$$

The above procedures yield daily (24 hour averaged) delta-deciview impacts calculated in relation to three situations: 1) current conditions; 2) annually averaged natural background conditions; and 3) the 20 percent best natural background conditions. Following compilation of the daily impacts, a simple sorting routine yields the maximum delta-deciview impact, as well as the number of days in which an impact of 0.5 (or greater) delta-deciviews occurs. As these values are available for each grid cell within the CAMx modeling domain, a spatial mask was applied to extract only those values which correspond to a Class I area. Figure 6-2 shows the 36 km and 12 km CAMx grid cells which contain any 1 km Class I area receptor. At 36 km resolution, thirty-four unique grid cells were identified. The 12 km grid yields 116 unique cells. For all Class I areas except Mingo (at 36 km resolution), more than one maximum delta-deciview value is produced as multiple CAMx grid cells are required to ensure complete coverage of a Class I area. The same situation appears in determining the number of days in which an impact greater than or equal to 0.5 delta-deciviews occurs. In terms of summarizing results, the maximum value within those grid cells representing a Class I area is of most importance. Again, a simple sorting function reveals maximum impacts.

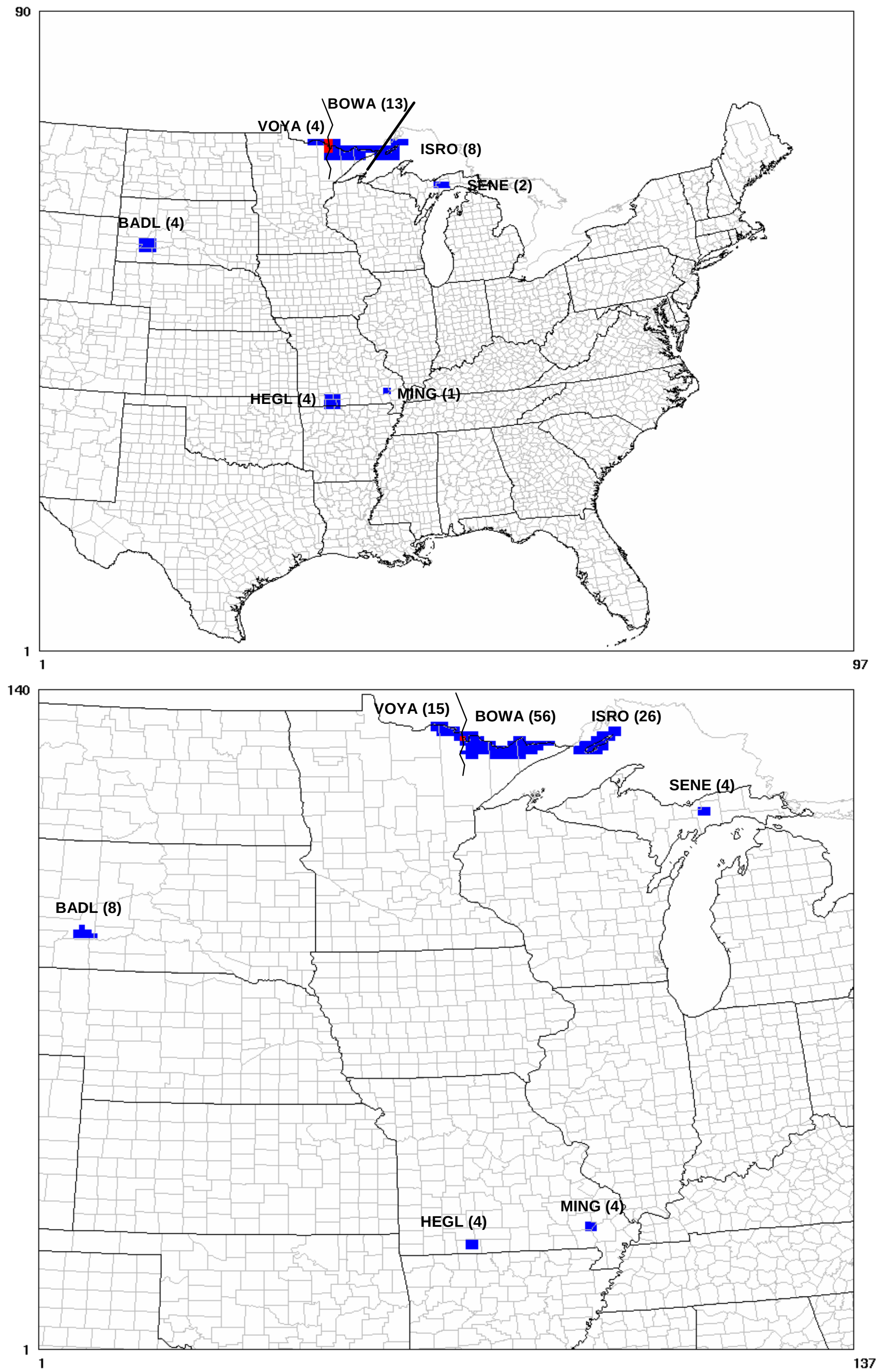

Figure 6-2. CAMx 36 km (top) and 12 km (bottom) grid cells containing a 1 km receptor for the seven Class I areas considered. The value in parentheses indicates the number of CAMx grid cells which contain a 1 km receptor. Grid cells which share areas of BOWA and VOYA are indicated in red.

6.3 MODELING SCENARIOS

Implementation of a scenario (sensitivity) run is completed through variable modification and subsequent comparison with the basecase through the calculations detailed above. Scenario goals are fundamentally driven by examining how visibility impacts change as a function of the BART-eligible source emission rates. For all cumulative CAMx modeling scenarios, fundamental scenario design involves zeroing the actual point source emissions of BART-eligible sources on a facility wide basis. The BART Guidelines prefer emission rates be based upon the maximum 24-hour averaged emission rate. However, continuous emissions monitoring (CEM) data is not available for Iowa's BART-eligible non-EGU facilities, which severely restricts calculation of the preferred emission rates. As a surrogate, emissions were zeroed on a facility wide basis across all pollutants (not just the visibility impairing pollutants). While the efficacy of this method is difficult to determine given a lack of CEM data, the methodology is judged reasonable by the IDNR based upon data availability and the inclusion of all facility emission units regardless of BART status.

In zeroing BART-eligible facility emissions, emphasis was placed upon the elevated point source emissions. Point source emissions are divided between two file types in the LADCO CAMx modeling system: elevated point and low point. Elevated point sources are identified in the emissions modeling stage through implementation of an idealized plume rise calculation. Using each stack's specific characteristics, a representative plume rise calculation is performed. Stacks yielding a plume rise exceeding a user supplied threshold are assigned to the elevated stack file, all other units are placed in the low point file and treated as an area source. Low point source file modification requires complex emissions modeling (while actual low point emission rates are expected to be negligible). Focusing upon the elevated point sources allows a scenario to be constructed using a simple post processor. Scenario construction therefore occurs through implementation of an efficient program capable of zeroing elevated stack emissions. The efficacy of this method is briefly discussed in section 6.4.1.

The unabridged cumulative modeling project consisted of numerous simulations. However, the majority of runs were completed in the project development stage utilizing BaseJ data and preliminary BART-eligible source lists. Due to uncertainty early in the BART identification process, BART-eligibility lists were dynamic and conservative in nature. As BART-eligible unit identification uncertainty minimized, a final BART list emerged. Concurrently the transition from BaseJ to BaseK occurred and pertinent scenarios were identified for implementation in a formal setting. Table 6-1 provides an overview of the three most informative simulations to be discussed in detail. Variability between these runs encompasses two areas:

1) Resolution
2) BART-eligible source lists.

Resolutions investigated included 36 and 12 kilometers. The BART-eligible lists include distinctions for CAIR versus non-CAIR units (in lieu of CAIR as BART). The final BART-eligible list contains only those sources legally identified as BART-eligible (as listed in Table 2-1). A comprehensive list of facilities considered under each scenario is provided in Table 6-2. From a practical perspective, Table 6-2 merely separates the EGU and non-EGU BART-eligible sources.

Table 6-1. Description of the IDNR BaseK cumulative modeling scenarios.

Scenario	Res. (km)	BART Source Emissions Processing Description
k2002ia36b0v2r1	36	All BART source emissions were zeroed out (both EGU and non-EGU facilities). Only elevated point source emissions were zeroed (low point emissions were not modified). Emissions were removed facility wide (not just BART units). The LADCO LAMB (low, area, mobile, biogenic) emission files were not modified.
k2002ia36b0v2r2	36	Similar to k2002ia36b0v2r1, except only non-EGU BART emissions were zeroed. (Again, only elevated point source units were impacted, with emissions zeroed facility-wide.) As above, the LADCO LAMB files were used.
k2002ia12b0v2r2	12	The same emissions scenario as k2002ia36b0v2r2 was implemented within a 12 km grid through flexi-nesting of the emissions data. Twelve km meteorological data was processed independent of the 36 km grid (*i.e.* the meteorological data was not flexi-nested).

Table 6-2. Facilities considered in each cumulative modeling simulation.

Facility Name and ID	k2002ia36b0v2r1	k2002ia36b0v2r2 k2002ia12b0v2r2
IPL - PRAIRIE CREEK GENERATING STATION (57-01-042)	X	
IPL - LANSING GENERATING STATION (03-03-001)	X	
CEDAR FALLS MUNICIPAL ELECTRIC UTILITY/CTS (07-02-005)	X	
IPL - BURLINGTON GENERATING STATION (29-01-013)	X	
IPL - M.L. KAPP GENERATING STATION (23-01-014)	X	
PELLA MUNICIPAL POWER PLANT (63-02-005)	X	
MUSCATINE POWER & WATER (70-01-011)	X	
CENTRAL IOWA POWER COOP. - FAIR STATION (70-08-003)	X	
MIDAMERICAN ENERGY CO. - COUNCIL BLUFFS ENERGY CTR (78-	X	
CITY OF AMES STEAM ELECTRIC PLANT/COMB TURB. (85-01-006)	X	
CENTRAL IOWA POWER COOP. - SUMMIT LAKE (88-01-004)	X	
MIDAMERICAN ENERGY CO. - GEORGE NEAL NORTH (97-04-010)	X	
MIDAMERICAN ENERGY CO. - GEORGE NEAL SOUTH (97-04-011)	X	
BP - DES MOINES TERMINAL (77-01-158)	X	X
BLOOMFIELD FOUNDRY, INC. (26-01-001)	X	X
EQUISTAR CHEMICALS, L.P. (23-01-004)	X	X
ADM CORN PROCESSING – CLINTON (23-01-006)	X	X
HOLCIM (US) INC. - MASON CITY (17-01-009)	X	X
JOHN DEERE FOUNDRY - WATERLOO (07-01-010)	X	X
THE DEXTER COMPANY (51-01-005)	X	X
KEOKUK STEEL CASTING, INC. - HAWKEYE FACILITY (56-01-025)	X	X
MONSANTO COMPANY - MUSCATINE 3670/6908/6909 (70-01-008)	X	X
GRIFFIN PIPE PRODUCTS COMPANY (78-01-012)	X	X
ALCOA INC. (82-01-002)	X	X
BP – BETTENDORF TERMINAL (82-02-024)	X	X
KOCH NITROGEN COMPANY - FORT DODGE (94-01-005)	X	X
TERRA NITROGEN - PORT NEAL COMPLEX (97-01-030)	X	X

6.4 RESULTS

Project initialization occurred through reproduction of the LADCO basecase air quality simulations. IDNR results were compared to the LADCO datasets to ensure the modeling system was configured and implemented correctly. Comparisons revealed agreement between the simulations at the most fundamental level, the binary computer output files.

Numerical evaluation is held for the BaseK/Final-BART-list scenarios in order to focus attention upon the formal results and avoid unnecessary details related to preliminary and subordinate data. No anomalies were found between the BaseJ and BaseK scenario runs, further minimizing the BaseJ scenarios' importance. However, a brief discussion of one preliminary run is informative.

6.4.1 PRELIMINARY DISCUSSION

The decision to focus upon only the elevated point sources was supported by sensitivity runs completed using BaseJ. The Emissions Modeling System (EMS) was used to zero the low point sources and create a new LAMB file. An existing post-processed elevated point source file was utilized to keep variable modification confined to the low point source file. The low point source emissions modeling processing was found to lower emissions rates by less than one ton per day per facility for all pollutants. Summing across all the BART-eligible facilities, NOx and SO2 differences still remained below one ton per day. Considering the low emission rate changes, in combination with considerable transport distances, only minor impacts were expected. Evaluation of the delta deciview impacts attributable to the low point source emissions did yield non-zero impacts. However, in terms of the results discussed below, the low point source delta-deciview impacts were insignificant in relation to any subject to BART determinations. As hypothesized, incurring the additional complexities associated with modification of the low point sources, through implementation of the EMS, is not warranted.

6.4.2 EGU AND NON-EGU: K2002IA36B0V2R1

As outlined in Table 6-1, scenario k2002ia36b0v2R1 eliminates all elevated point source emissions from both EGU and non-EGU BART-eligible sources. The resulting cumulative visibility impacts are depicted in Figure 6-3, arranged in a four panel plot. The upper left panel provides the maximum delta-deciview impacts as compared against annually averaged natural background conditions. The upper right panel depicts the number of days in which delta-deciview impacts greater than or equal to 0.5 dv were calculated. This pattern is repeated in the lower panels, with impacts compared against the 20% best natural background conditions. The analysis shows delta-deciview impacts consistently and frequently exceed 0.5 dv. Maximum values are provided in Table 6-3. Impacts range between 2.23 ddv (BADL) and 3.17 ddv (SENE) under annually averaged natural background conditions. The number of days registering an impact greater than or equal to 0.5 ddv ranges between 22 (BADL) and 47 (SENE). As expected, the impacts increase when compared against the 20% best natural background conditions, ranging from 2.79 ddv (BADL) to 4.41 ddv (SENE) with the number of days registering an impact greater than or equal to 0.5 ddv bound between 28 (BADL) and 73 (MING). (For additional perspective, the top ten ranked impacts are provided for each Class I area in Appendix 11.1.) The IDNR can clearly conclude that in the absence of CAIR potential Iowa BART sources would not be eligible for cumulative exclusion from subject to BART analyses.

6.4.3 NON-EGU ONLY: K2002IA36B0V2R2

Graphical and tabular results from scenario k2002ia36b0v2r2 are shown in Figure 6-4 (note the change in scale versus Figure 6-3) and Table 6-4. Modeled impacts decrease sharply versus scenario k2002ia36b0v2r1, as only non-EGU emissions are modified. In contrast to scenario k200ia36b0v2r1, where impacts greater than 0.5 ddv are common and frequent, only three of the seven sites registered impacts above 0.5 ddv: BOWA, ISLE, and SENE. In terms of frequency, BOWA and SENE each registered one impact greater than 0.5 ddv. Isle Royale registered two days with a delta-deciview greater than or equal to 0.5 dv. Additional insight regarding the frequency of impacts is provided in Appendix 11.2, where the individual top ten Class I area impacts are provided. The maximum impacts predicted under annually averaged natural background conditions ranged from 0.15 (BADL) to 0.64 (ISLE) ddv.

The evaluation conducted against the 20 percent best natural background conditions shows that six of the seven Class I areas register impacts greater than 0.5 ddv. Badlands remains the only Class I area under the 0.5 ddv threshold. Isle Royale again exhibits the highest impact, at 0.92 ddv, with the other five Class I areas at or above 0.53 ddv. The Badlands is the only area which does not register an increase in the frequency of ddv impacts greater than 0.5 dv when evaluated against the 20% best natural background conditions, while Isle Royale exhibits the most variability, with a four day increase. All other areas demonstrate only moderate variability, with one or two additional daily impacts greater than 0.5 ddv.

These results establish the cumulative visibility impacts upon nearby Class I areas from all non-EGU BART-eligible sources. If one considers natural background conditions and maximum impacts, a 0.64 ddv is produced. However, a maximum of only two days are of concern. Under the 20% best natural background conditions, the maximum impact increases to 0.92 ddv, with the frequency of impacts increasing to 6 days. As results remain near criteria provided in the BART guidance, increased model resolution is sought to assist in refining the impacts.

6.4.4 12 KM IMPACTS: K2002IA12B0V2R2

The design of scenario k2002ia12b0v2r2 mirrors that of k2002ia36b0v2r2 and implementation differs only in the inclusion of a 12 km domain. To ensure consistency in the emission inventory, emission from the 36 km domain were flexi-nested within the 12 km domain. A readily available 12 km MM5 dataset mitigated the need to flexi-nest the meteorology. While previous model performance evaluation did not demonstrate a statistical advantage to the 12 km MM5 simulation, spatial features and gradients are subject to a greater level of detail, and no disadvantages were identified within the 12 km meteorological fields as compared with 36 km data (Johnson, 2007).

The visibility impacts of the 12 km scenario are shown in Figure 6-5 and Table 6-5. The maximum impacts predicted under annually averaged natural background conditions ranged from 0.24 (BADL) to 0.63 (BOWA) ddv. Compared against the 20% best natural background conditions, impacts range from 0.3 (BADL) to 0.93 (BOWA) ddv. Under the 20% best natural background conditions, a maximum of five days (ISLE) occur in which impacts greater than or equal to 0.5 ddv are calculated. Considering annually averaged natural background conditions, delta deciview impacts greater than or equal to 0.5 dv are found on no more than two days.

Differences between the 12 and 36 km results (provided in Table 6-5 within parentheses; positive values indicate the 12 km grid generated greater visibility impacts) exhibit no pattern. Both increases and decreases in visibility impacts are found among the sites. Assessment of the annually averaged natural background conditions shows the largest change in visibility impacts occurs at VOYA, with impacts increasing 0.17 ddv, from 0.36 to 0.53 ddv. Alternatively, the impacts at SENE are reduced 0.15 dv, from 0.58 to 0.43 dv. The number of days with impacts at or above 0.5 dv fluctuates by no more than one day. As expected, a similar pattern is produced under the 20% best natural background conditions. Under 20% best natural conditions, the 12 km grid increased the visibility impacts at VOYA by 0.25 dv, while impacts at SENE were reduced by 0.21 dv. The number of days in which the 12 km results pushed the impacts above the 0.5 ddv threshold (versus 36 km data) changed by no more than 2 days. Given the increased sensitivity of the 20% best natural background conditions to changes in concentrations, the variability is expected.

In general, the variability encountered through comparison of the 12 km grid is well within expectations. While delta-deciview changes up to 0.25 dv were shown, such a change requires only a modest modification in species concentrations. The number of days in which ddv impacts greater than or equal to 0.5 occurred showed only minor fluctuations (at most 2 days). The results suggest the 12 km simulations leads to more active chemistry, as expected, but major anomalies between the 12 and 36 km results are not created. In summary, considering natural background conditions, the maximum impact modeled is 0.63 ddv with a maximum of only 2 days above the 0.5 ddv threshold. Under the 20% best natural background conditions, the maximum impact increases to 0.93 ddv, while the maximum frequency of impacts increases to 5 days. Appendix 11.3 contains additional detail regarding the frequency and magnitude of impacts above 0.5 ddv.

As mentioned in Section 6.2 the equations coded within the IDNR software, in combination with scenario design, allows calculation of visibility impacts in relation to current conditions. While not a regulatory requirement of subject to BART determinations, an investigation of the current condition visibility impacts attributable to Iowa's non-EGU BART-eligible sources does provide a different perspective and is provided for informational purposes. This analysis is conceptually equivalent to determining the actual (year 2002) visibility improvements expected at nearby Class I areas if all 14 non-EGU BART-eligible sources modeled within scenario k2002ia12b0v2r2 (see Table 6-2) were to cease operations. Results are provided in Figure 6-6 and Table 6-6. Visibility conditions are expected to improve at most 0.19 dv (at ISLE). Averaged over the 7 Class I areas, visibility conditions improve at most 0.12 dv, or approximately one tenth the level detectable by a human observer.

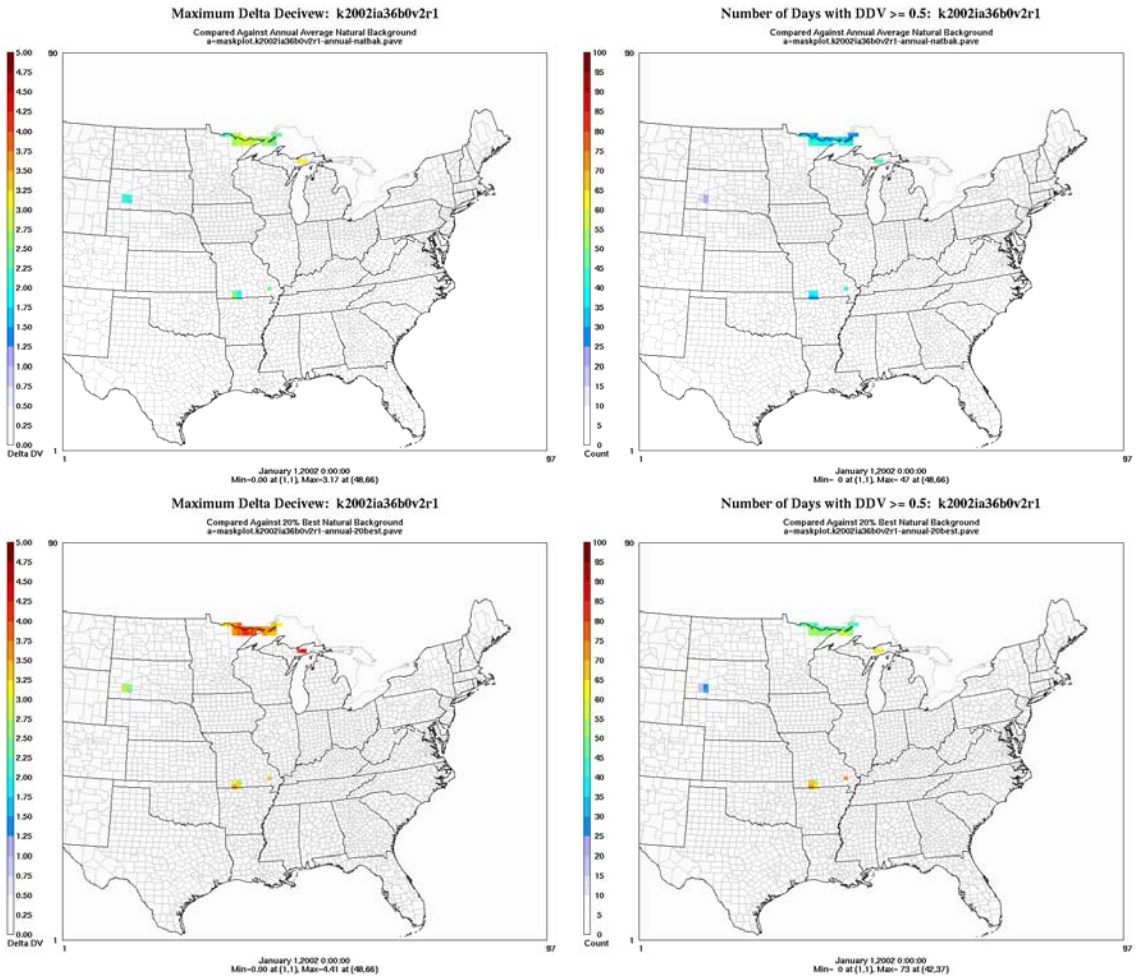

Figure 6-3. Scenario k2002ia36b0v2r1. Four panel plot with maximum delta-deciview impacts as compared against annually averaged natural background conditions (upper left) and the number of days with delta-deciview impacts greater than or equal to 0.5 dv (upper right). Lower panels repeat the calculations referencing the 20% best natural background conditions. Data are depicted at grid cells containing any 1 km Class I area receptor.

Table 6-3. Scenario k2002ia36b0v2r1: Class I area maximum impacts (values extracted from the above figure).

Site	Annual Avg. Natural Background		20% Best Natural Background	
	Maximum DDV	Number of Days DDVs ≥ 0.5	Maximum DDV	Number of Days DDVs ≥ 0.5
BADL	2.23	22	2.79	28
BOWA	2.97	41	4.16	53
HEGL	2.65	36	3.72	71
ISLE	2.70	41	3.72	56
MING	2.34	40	3.32	73
SENE	3.17	47	4.41	63
VOYA	2.40	33	3.41	49

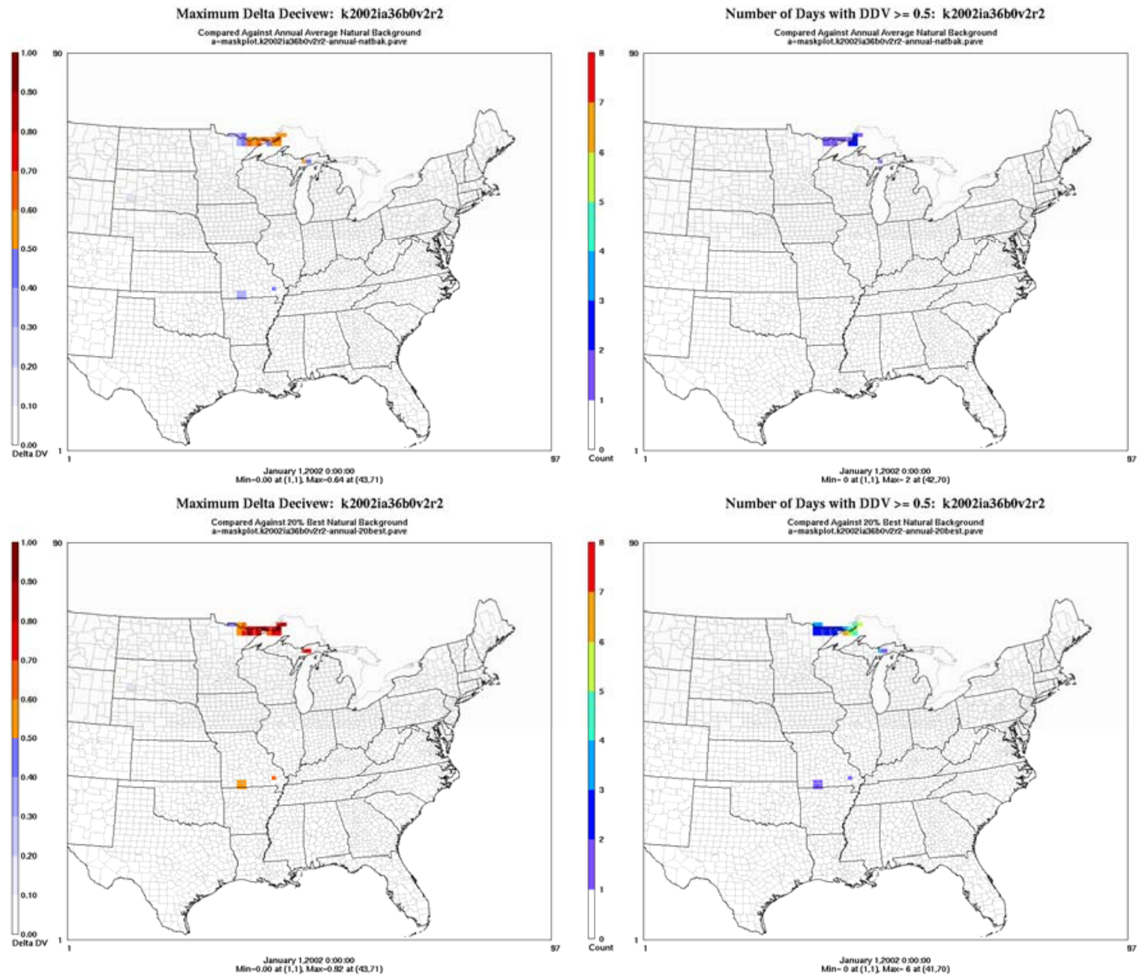

Figure 6-4. Scenario k2002ia36b0v2r2. Four panel plot with maximum delta-deciview impacts as compared against annually averaged natural background conditions (upper left) and the number of days with delta-deciview impacts greater than or equal to 0.5 dv (upper right). Lower panels repeat the calculations referencing the 20% best natural background conditions. Data are depicted at grid cells containing any 1 km Class I area receptor.

Table 6-4. Scenario k2002ia36b0v2r2: Class I area maximum impacts (values extracted from the above figure).

Site	Annual Avg. Natural Background		20% Best Natural Background	
	Maximum DDV	Number of Days DDVs ≥ 0.5	Maximum DDV	Number of Days DDVs ≥ 0.5
BADL	0.15	0	0.20	0
BOWA	0.62	1	0.91	3
HEGL	0.38	0	0.57	1
ISLE	0.64	2	0.92	6
MING	0.41	0	0.60	1
SENE	0.58	1	0.85	3
VOYA	0.36	0	0.53	2

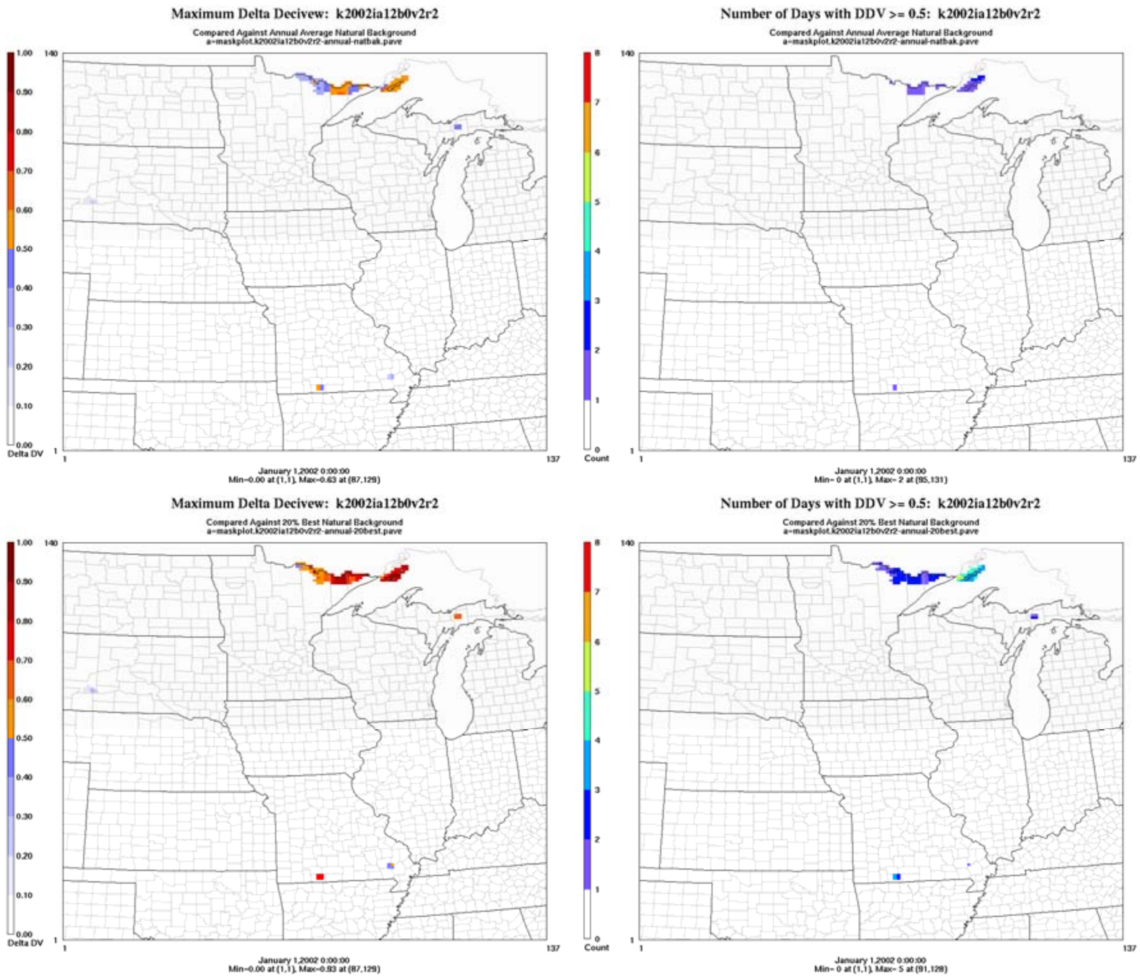

Figure 6-5. Scenario k2002ia12b0v2r2. Four panel plot with maximum delta-deciview impacts as compared against annually averaged natural background conditions (upper left) and the number of days with delta-deciview impacts greater than or equal to 0.5 dv (upper right). Lower panels repeat the calculations referencing the 20% best natural background conditions. Data are depicted at grid cells containing any 1 km Class I area receptor.

Table 6-5. Scenario k2002ia12b0v2r2: Class I area maximum impacts (values extracted from the above figure). Values in parentheses indicate the differences as compared to the 36 km results. Calculated as (k2002ia12b0v2r2 - k2002ia36b0v2r2).

Site	Annual Avg. Natural Background		20% Best Natural Background	
	Maximum DDV	Number of Days DDVs ≥ 0.5	Maximum DDV	Number of Days DDVs ≥ 0.5
BADL	0.24 (0.09)	0 (0)	0.30 (0.10)	0 (0)
BOWA	0.63 (0.01)	1 (0)	0.93 (0.02)	2 (-1)
HEGL	0.52 (0.14)	1 (1)	0.76 (0.19)	3 (2)
ISLE	0.62 (-0.02)	2 (0)	0.90 (-0.02)	5 (-1)
MING	0.34 (-0.07)	0 (0)	0.50 (-0.10)	1 (0)
SENE	0.43 (-0.15)	0 (-1)	0.64 (-0.21)	2 (-1)
VOYA	0.53 (0.17)	1 (1)	0.78 (0.25)	2 (0)

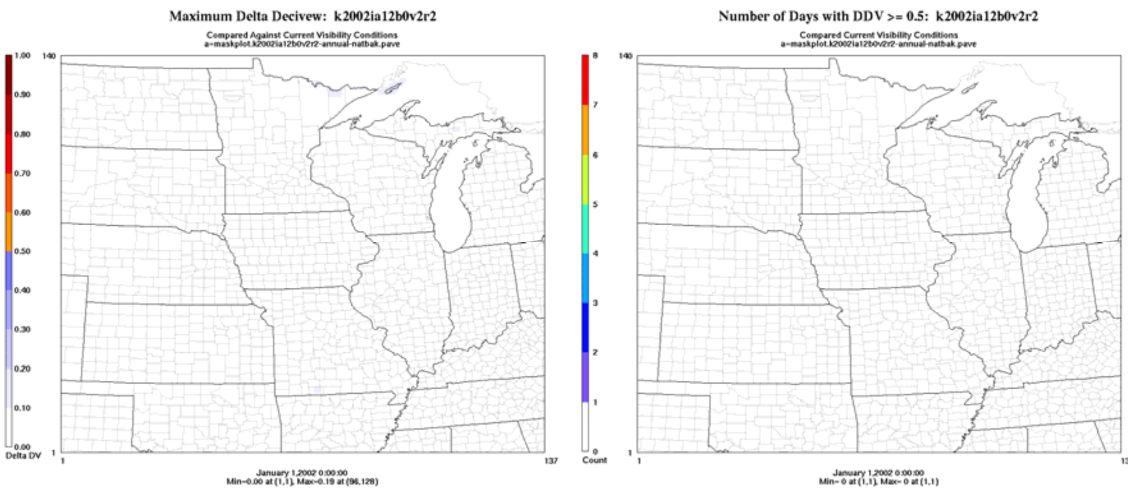

Figure 6-6. Scenario k2002ia12b0v2r2. Two panel plot with maximum delta-deciview impacts as compared against current (year 2002) conditions (left) and the number of days with delta-deciview impacts greater than or equal to 0.5 dv (right). Data are depicted at grid cells containing any 1 km Class I area receptor.

Table 6-6. Scenario k2002ia12b0v2r2: Class I area maximum impacts (values extracted from the above figure). Visibility impacts are in terms of current (year 2002) visibility condition.

Site	Current (2002) Visibility Impacts	
	Maximum DDV	Number of Days DDVs ≥ 0.5
BADL	0.12	0
BOWA	0.11	0
HEGL	0.11	0
ISLE	0.19	0
MING	0.08	0
SENE	0.13	0
VOYA	0.1	0

7. PM, VOC, AND NH3

7.1 OVERVIEW

The BART Guidelines list five species as visibility impairing pollutants: SO2, NOx, PM, VOC, and NH3. Any visibility impairment attributable to SO2 or NOx emissions is explicitly addressed in all above methods, however, only within the cumulative modeling (CAMx) framework are the visibility impacts attributable to VOC quantified. While NH3 emissions are modeled in CAMx the predicted particulate ammonium concentrations must be neglected in order to remain consistent with the IMPROVE method which assumes full neutralization of sulfates and nitrates. Source specific NH3 emissions are not considered in either Q/d or CALPUFF. PM emissions are included in all the above methods, however, PM impacts from electrical generating units have not been quantified. The following discussions address these deficiencies.

7.2 PM

While CAIR satisfies BART for EGU SO2 and NOx emissions, PM emissions require consideration. A return to the CALPUFF model plant analysis offers a solution for efficiently analyzing EGU PM emissions. Model year 2004 was selected in order to generate maximum[18] impacts. Two scenarios were completed, using emission rates of 10,000 and 5000 tpy of PM (conservatively modeled as PM2.5). No NOx or SO2 emissions were modeled. The model plant configuration was modified to reflect idealized EGU stack parameters, obtained from EPA's *CALPUFF Analysis in Support of the June 2005 Changes to the Regional Haze Rule* (2005).

Results are depicted in Figure 7-1. No impacts above 0.5 dv are observed at any site under annually averaged natural background conditions with PM emissions of 10,000 tpy. Under the 20% best natural background conditions no impacts exceeding the 98th percentile occur. Reducing the emissions to 5000 tpy, no impacts above 0.5 dv are produced under either natural background condition. In terms of scale, Iowa's largest PM10 source (an EGU (not BART-eligible)) emits 3174 tpy[19], a value approximately 36.5% below the level which yields no visibility impacts. Based upon these results the IDNR concludes that EGU PM emissions from Iowa BART sources will not cause or contribute to visibility impairment at any nearby Class I area. As PM emission rates from non-EGU BART-eligible sources remain below those of the EGU's, the aforementioned conclusion is also applicable to Iowa's non-EGU BART-eligible units.

[18] Previous analysis of the model plant results showed 2004 impacts exceeded 2002 and 2003 values.
[19] Facility wide total.

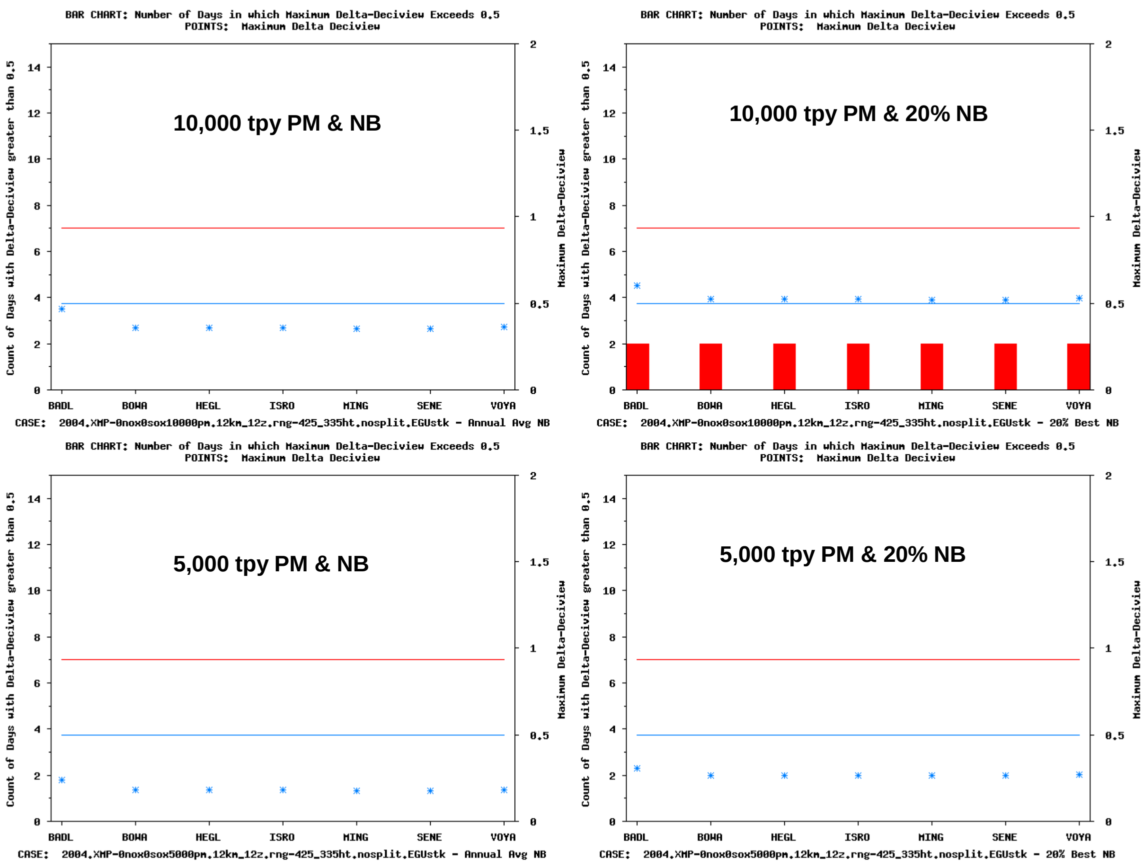

Figure 7-1. PM deciview impacts from four Iowa model plant configurations: results for year 2004 with total PM emissions of 10,000 and 5000 tpy (no NOx or SO2 emissions), as compared against annually averaged natural background (NB) conditions and 20% best NB conditions. Puff splitting was not enabled for simplicity. Idealized stack parameters represent EGU values.

7.3 VOC AND NH3

The BART Guidelines (70 FR 39160) provides that: “[States] should use [their] best judgment in deciding whether VOC or NH3 emissions from a source are likely to have an impact on visibility in an area.” The guidelines go on to stress that a formal showing is not required in determining that an individual source is subject to BART review due to VOC or NH3 emissions. Conversely, a subject to BART determination made through VOC or NH3 emissions requires complete documentation and justification of the assessment. As VOC and NH3 emissions are clearly of a different focus than SO2, NOx, or PM emissions, the IDNR concludes that quantitative analyses of emissions inventory data provides sufficient evidence to confirm that Iowa point source NH3 and VOC emissions do not cause or contribute to any visibility impairment in any Class I area.

A simple scale analysis demonstrates that point source emissions of NH3 and VOC are insignificant in comparison to other sources and source types. Summing *all* (not just BART-eligible sources) 2002 Iowa point source NH3 emissions yields and emission rate of 3366 tpy. Area source emissions are approximately seventy-seven times higher, at ~260,000 tpy (Figure 7-2). VOC emissions from Iowa’s BART-eligible sources comprise only 4% of the total (anthropogenic plus biogenic) 2002 VOC inventory (Figure 7-3) and are considered insignificant in terms of visibility impacts. Therefore point source NH3 and VOC emissions will not be evaluated for visibility impacts.

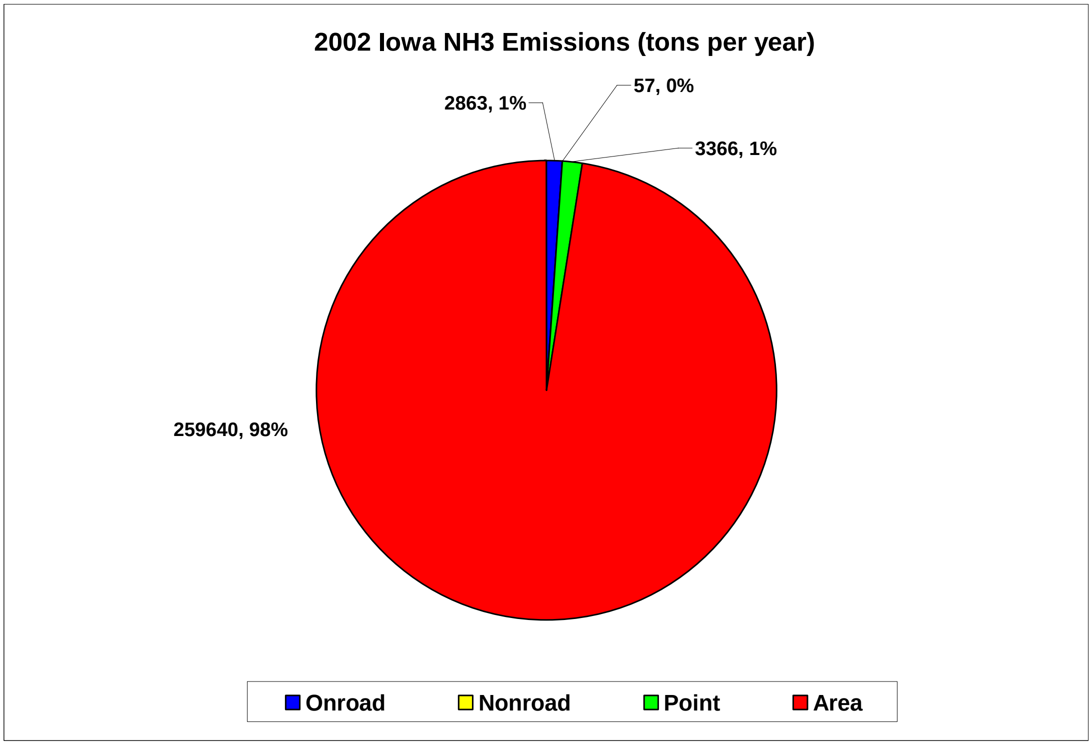

Figure 7-2. Distribution of the 2002 Iowa NH3 emission inventory by source category. Point sources include all Iowa facilities, BART and non-BART.

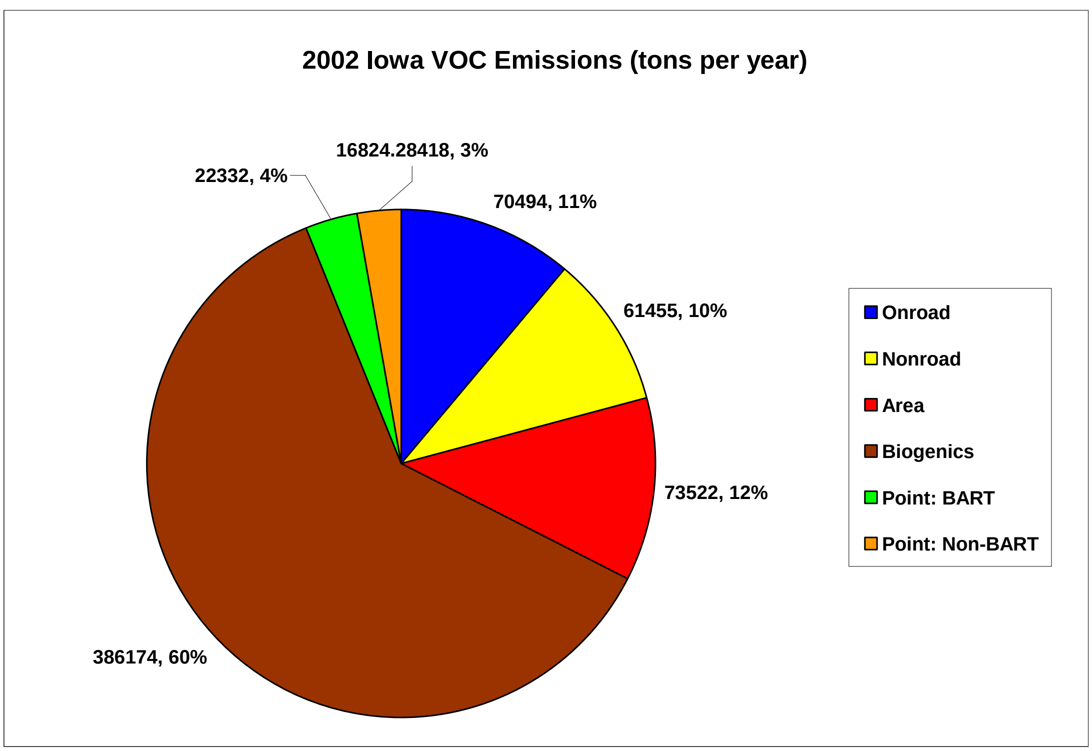

Figure 7-3. Distribution of the 2002 Iowa VOC emission inventory by source category.

8. SUBJECT TO BART DETERMINATIONS

8.1 EGU

The IDNR is utilizing the EPA determination that CAIR is better than BART. As codified in 40 CFR §51.308(e)(4): "A State that chooses to meet the emission reduction requirements of the Clean Air Interstate Rule (CAIR) by participating in one or more of the EPA-administered CAIR trading programs for SO2 and NOx need not require BART-eligible EGUs subject to such trading programs in the State to install, operate, and maintain BART for the pollutants covered by such trading programs in the State." All BART-eligible EGU units are subject to the CAIR SO2 and NOx trading rules, however, the CAIR does not address EGU PM emissions. CALPUFF model plant methods were used to investigate PM emissions. Section 7.2 discussed EGU PM emissions and concluded that no Iowa EGU PM emissions are reasonably anticipated to cause or contribute to any visibility impairment in any Class I area. Chapter 7 also addressed VOC and NH3 emissions and reached a similar conclusion. These findings yield the determination that no Iowa BART-eligible EGUs are subject to BART.

8.2 NON-EGU

Turning to the fourteen non-EGU BART-eligible sources, consideration of several analytical methods is required to complete the subject to BART determinations. Reviewing the Q/d results enables a straightforward classification of facilities. At the most conservative level of Q/5d, with Q based upon potential emission rates, eleven facilities fall below the 1.0 threshold:

- Koch Nitrogen Company
- Monsanto Company Muscatine
- Terra Nitrogen Port Neal
- BP - Bettendorf Terminal
- BP - Des Moines Terminal
- Bloomfield Foundry, Inc.
- Griffin Pipe Products Co.
- John Deere Foundry Waterloo
- Keokuk Steel Castings
- The Dexter Company
- Alcoa, Inc.

By ranking the above facilities in terms of potential to emit (summing SO2, NOx, and PM emissions across all BART-eligible units), Alcoa Inc. tops the list at 1507 tpy. The CALPUF model plant analyses established 3000 tpy as the threshold below which a BART-eligible source would not cause or contribute to visibility impairment. Potential emissions from these facilities are at most approximately half the proposed threshold. The Q/d evaluation, in tandem with the CALPUFF model plant evaluation leads the IDNR to conclude that these facilities will not cause or contribute to any visibility impairment in any Class I area, and are therefore not subject to BART.

This decision is supported by the cumulative modeling impacts. Actual facility emissions (summed over SO2, NOx, PM, VOC and the 11 facilities listed above) totaled 3700 tpy. Inclusion of the remaining non-EGU facilities, Equistar Chemicals, Holcim, Inc., and ADM (Clinton) brings the total to 29,178 tpy. Under scenario k2002ia12b0v2r2, the maximum impact generated (in comparison to the 20% best natural background conditions) was found to be 0.93 deciviews. Impacts above 0.5 dv were recorded on a maximum of 5 days at nearby Class I areas. The 11 facilities listed above are unlikely to have played a significant role in the cumulative modeling visibility impacts when their total emissions account for only 12.7% of the total. Of the three remaining non-EGU BART-eligible sources, Equistar Chemical is an outlier in comparison to ADM (Clinton) and Holcim. Equistar Chemical's potential and actual emissions are dominated by VOC[20] and not SO2 and NOx. While potential emissions of SO2 and NOx exceed the 5000 tpy scenario examined within the CALPUFF model plant framework, actual emission rates are insignificant in reference to the CALPUFF model plant and Q/5d results. IDNR therefore concludes that Equistar Chemical could not reasonably cause or contribute to visibility impairment at any Class I area.

Holcim and ADM (Clinton) emerge as the sources which fail both screening methods. Almost all Q/d metrics exceed the 1.0 significance level, while SO2+NOx emissions (potentials and actuals) exceed both the 3000 and 5000 tpy scenarios examined with CALPUFF. As neither Q/d nor CALPUFF utilize the most accurate science available in terms of transport or chemistry, the CAMx cumulative modeling analyses remain the best method available for assessing the visibility impacts from these sources. Scenario k2002ia12b0v2r2 does yield visibility impacts above 0.5 deciviews at nearby Class I areas. Referencing annual average natural background conditions, four of the seven sites registered impacts above 0.5 dv. The maximum impact of 0.63 delta-deciviews occurred at Boundary Waters Canoe Area. Considering all Class I areas, at most two days with a visibility impact greater than or equal to 0.5 ddv were found under natural background conditions. This value increases to 5 under the more conservative approach involving the 20% best natural background conditions. Based on these considerations, the cumulative CAMx modeling results are inconclusive regarding the individual subject to BART determinations for ADM (Clinton) and Holcim. Additional information will therefore be analyzed.

The absence of an accurate method for determining single source visibility impacts from sources far removed from Class I areas complicates Iowa's subject to BART determination process. Lacking a sophisticated method, an alternative exists through scaling the cumulative modeling impacts according to emission rates. Utilizing the maximum deciview impacts from the most relevant scenario (k2002ia12b0v2r2), at the stringent 20% best natural background conditions, a value of 0.93 dv is produced. Considering the actual SO2, NOx and PM emissions zeroed out in this scenario, Holcim accounts for 6828 tpy of the 22,909 tpy total, or 30%. ADM (Clinton) emits 12,755 tpy, or 56%. The resultant scaled visibility impact attributable to Holcim would thus be 0.28 dv, well below the 0.5 dv threshold. ADM's contribution would be 0.52 dv. This additional information supports the determination that Holcim does not cause or contribute to visibility impairment at any Class I area. The same determination for ADM (Clinton) would be more difficult to justify.

Recent PSD permitting activities related to ADM (Clinton) dramatically alter the situation. ADM (Clinton) will be replacing all fourteen boilers[21] currently in operation at their facility, including both BART-eligible boilers, No. 7 and No. 8, and replacing them with two natural gas and three coal fired boilers. The coal fired boilers require installation and operation of a baghouse, selective non-catalytic reduction, and limestone injection flue gas desulfurization. Construction permit limits establish an annual cap applicable across all 5 new units. SO2

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[20] In terms of visibility impairment, VOC emissions were addressed in Chapter 7.3 and found to be negligible.
[21] These boilers account for all facility SO2 emissions and a great majority of the NOx emissions.

emissions are not to exceed 3629 tpy, NOx emissions are not to exceed 1445 tpy. These limits represent best available control technology (BACT) emission rates as required under the new source review PSD program. The applicable IDNR permit numbers are 05-A-313-P, 05-A-314-P, 05-A-315-P for the coal-fired boilers, and 05-A-316-P, 05-A-317-P for the natural gas fired boilers. As the BART-eligible boilers must be permanently shut down by 09/13/2008 and the replacement boilers satisfy BACT, the IDNR concludes ADM (Clinton) is not subject to BART.

8.3 SUMMARY

The absence of a single tool capable of accurately assessing single source visibility impacts over transport distances in the 500 km range required the use of a variety of technical tools and analyses to complete subject to BART determinations. Implementation of Q/d, CALPUFF, CAMx, and emission inventory scale analysis methods provided the IDNR with the analytical data necessary to make informed decisions. Recent permitting activities involving the removal of BART-eligible units, and EPA's determination that CAIR constitutes BART for NOx and SO2 emissions from EGUs provided additional perspective and resolution. In consideration of all data, the IDNR concludes that BART-eligible sources located in Iowa are not reasonably anticipated to cause or contribute to any impairment of visibility in any Class I area and are therefore not subject to BART.

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10. CALPUFF APPENDICIES

10.1 APPENDIX: TERREL

The following table provides a listing of the variables and subsequent values utilized in the IDNR CALPUFF model plant configuration for the TERREL preprocessor.

Variable	IDNR Value
NTDF	4
OUTFIL	terr12km.dat
LSTFIL	terr12km.lst
PLTFIL	qatr12km.grd
SAVEFIL	terr.sav
LCFILES	T
GTOPO30	W140N90.DEM
GTOPO30	W100N90.DEM
GTOPO30	W140N40.DEM
GTOPO30	W100N40.DEM
DUSGS90	WGS-G
DUSGS30	NAS-C
DARM3	NAS-C
D3CD	WGS-G
DDMDF	NAS-C
DGTOPO30	WGS-G
DUSGSLA	ESR-S
DNZGEN	WGS-G
DGEN	WGS-G
LPREV	F
LXY	F
NXYCOL	2

Variable	IDNR Value
XYRADKM	0.1
IMODEL	1
ITHRES	75
PMAP	LCC
FEAST	0
FNORTH	0
IUTMZN	19
UTMHEM	N
RLAT0	40.0N
RLON0	97.0W
RLAT1	33.0N
RLAT2	45.0N
DATUM	WGS-G
IGRID	1
XREFKM	-792
YREFKM	-720
NX	171
NY	165
DGRIDKM	12
NRING	0
NRAYS	0
IPROC	2

10.2 APPENDIX: CTGPROC

The following table provides a listing of the variables and subsequent values utilized in the IDNR CALPUFF model plant configuration for the CTGPOROC preprocessor.

Variable	IDNR Value
LUINDAT	noameric.lu
LUDAT	lulc12km.dat
RUNLST	lulc12km.lst
LCFILES	T
LFINAL	T
LPREV	F
LULC	2
IGLAZR	1
DCTG	NAS-C
DUSGSLA	ESR-S
DNZGEN	WGS-G
ITHRESH	75
PMAP	LCC
FEAST	0
FNORTH	0
IUTMZN	19
UTMHEM	N
RLAT0	40.0N
RLON0	97.0W
RLAT1	33.0N
RLAT2	45.0N
DATUM	WGS-G
XREFKM	-792
YREFKM	-720
NX	171
NY	165
DGRIDKM	12

10.3 Appendix: MAKEGEO

The following table provides a listing of the variables and subsequent values utilized in the IDNR CALPUFF model plant configuration for the MAKEGEO preprocessor.

Variable	IDNR Value
LUDAT	lulc12km.dat
TERRDAT	terr12km.dat
GEODAT	geo12.dat
RUNLST	makegeo.lst
LCFILES	T
LTERR	T
IXQA	75
IYQA	75
PMAP	LCC
FEAST	0
FNORTH	0
IUTMZN	19
UTMHEM	N
RLAT0	40.0N
RLON0	97.0W
RLAT1	33.0N
RLAT2	45.0N
DATUM	WGS-G
XREFKM	-792
YREFKM	-720
NX	171
NY	165
DGRIDKM	12
NOUTCAT	14
IWAT1	50
IWAT2	55
OUTCAT	10, 20, -20, 30, 40, 51, 54, 55
OUTCAT	60, 61, 62, 70, 80, 90
NINCAT	38
NUMWAT	5
NSPLIT	0
CFRACT	0.5
IMISS	55
IWAT	51
IWAT	52
IWAT	53
IWAT	54
IWAT	55

Landuse Properties
11, 0.5, 0.18, 1.0, 0.20, 0.0, 1.0, 10
12, 1.0, 0.18, 1.5, 0.25, 0.0, 0.2, 10
13, 1.0, 0.18, 1.5, 0.25, 0.0, 0.2, 10
14, 1.0, 0.18, 1.5, 0.25, 0.0, 0.2, 10
15, 1.0, 0.18, 1.5, 0.25, 0.0, 0.2, 10
16, 1.0, 0.18, 1.5, 0.25, 0.0, 0.2, 10
17, 1.0, 0.18, 1.5, 0.25, 0.0, 0.2, 10
21, 0.25, 0.15, 1.0, 0.15, 0.0, 3.0, 20
22, 0.25, 0.15, 1.0, 0.15, 0.0, 3.0, 20
23, 0.25, 0.15, 1.0, 0.15, 0.0, 3.0, 20
24, 0.25, 0.15, 1.0, 0.15, 0.0, 3.0, 20
31, 0.05, 0.25, 1.0, 0.15, 0.0, 0.5, 30
32, 0.05, 0.25, 1.0, 0.15, 0.0, 0.5, 30
33, 0.05, 0.25, 1.0, 0.15, 0.0, 0.5, 30
41, 1.0, 0.1, 1.0, 0.15, 0.0, 7.0, 40
42, 1.0, 0.1, 1.0, 0.15, 0.0, 7.0, 40
43, 1.0, 0.1, 1.0, 0.15, 0.0, 7.0, 40
51, 0.001, 0.1, 0.0, 1.0, 0.0, 0.0, 51
52, 0.001, 0.1, 0.0, 1.0, 0.0, 0.0, 51
53, 0.001, 0.1, 0.0, 1.0, 0.0, 0.0, 51
54, 0.001, 0.1, 0.0, 1.0, 0.0, 0.0, 54
55, 0.001, 0.1, 0.0, 1.0, 0.0, 0.0, 55
61, 1.0, 0.1, 0.5, 0.25, 0.0, 2.0, 61
62, 0.2, 0.1, 0.1, 0.25, 0.0, 1.0, 62
71, 0.05, 0.3, 1.0, 0.15, 0.0, 0.05, 70
72, 0.05, 0.3, 1.0, 0.15, 0.0, 0.05, 70
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76, 0.05, 0.3, 1.0, 0.15, 0.0, 0.05, 70
77, 0.05, 0.3, 1.0, 0.15, 0.0, 0.05, 70
81, 0.2, 0.3, 0.5, 0.15, 0.0, 0.0, 80
82, 0.2, 0.3, 0.5, 0.15, 0.0, 0.0, 80
83, 0.2, 0.3, 0.5, 0.15, 0.0, 0.0, 80
84, 0.2, 0.3, 0.5, 0.15, 0.0, 0.0, 80
85, 0.2, 0.3, 0.5, 0.15, 0.0, 0.0, 80
91, 0.05, 0.7, 0.5, 0.15, 0.0, 0.0, 90
92, 0.05, 0.7, 0.5, 0.15, 0.0, 0.0, 90

10.4 APPENDIX: CALMM5

The following table provides a listing of the variables and subsequent values utilized in the IDNR CALPUFF model plant configuration for the CALMM5 preprocessor.

Variable	IDNR Value
Heading	Iowa DNR CALMM5v2.4 run2 36km 2002mm5v363-Iowa
Number of MM5 Output files (0 for auto)	2
MM5 input file name	mmout_a
MM5 input file name	mmout_b
CALMM5 output file name	20021231.m3d *(an example)*
CALMM5 list file name	20021231.lst *(an example)*
Options for selecting a region	2
Southernmost Grid Cell	45
Northernmost Grid Cell	99
Westernmost longitude Grid Cell	61
Easternmost longitude Grid Cell	117
Starting date	2002123107 *(an example)*
Ending date	2003010106 *(an example)*
Output format	1
	Keep this line -
Output W, RH, cloud and rain, ice and snow, graupel	1 1 1 1 0
Flag for 2-D variables output	0
Lowest extraction level in MM5	1
Highest extraction level in MM5	34

10.5 APPENDIX: CALMET

The following table provides a listing of the variables and subsequent values utilized in the IDNR CALPUFF model plant configuration for the CALMET preprocessor. The default values recommended by the IWAQM workgroup are provided for comparison. A value of "#N/A" indicates a default setting was not provided in the IWAQM Appendices.

Variable	IDNR Value	IWAQM Default
GEODAT	../input/geo12km.dat	#N/A
MM4DAT	OUTFILE.m3d	#N/A
METLST	cmet.OUTFILE.lst	#N/A
METDAT	cmet.OUTFILE.dat	#N/A
LCFILES	T	#N/A
NUSTA	0	User Defines
NOWSTA	0	#N/A
IBYR	IYEAR	User Defines
IBMO	IMONTH	User Defines
IBDY	IDAY	User Defines
IBHR	1	User Defines
IBTZ	6	User Defines
IRLG	24	User Defines
IRTYPE	1	1
LCALGRD	T	T
ITEST	2	#N/A
PMAP	LCC	#N/A
FEAST	0	#N/A
FNORTH	0	#N/A
IUTMZN	19	User Defines
UTMHEM	N	#N/A
RLAT0	40N	40
RLON0	97W	90
XLAT1	33N	30
XLAT2	45N	60
DATUM	WGS-G	#N/A
NX	171	User Defines
NY	165	User Defines
DGRIDKM	12	User Defines
XORIGKM	-792	User Defines
YORIGKM	-720	User Defines
NZ	12	User Defines
ZFACE	0., 20., 40., 73., 146., 369., 598., 1071., 1569., 2095., 2462., 2942., 3448.	User Defines
LSAVE	T	T
IFORMO	1	1
LPRINT	F	#N/A
IPRINF	1	#N/A
IUVOUT	0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0	#N/A
IWOUT	0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0	#N/A

Variable	IDNR Value	IWAQM Default
ITOUT	0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0	#N/A
STABILITY	0	#N/A
USTAR	0	#N/A
MONIN	0	#N/A
MIXHT	0	#N/A
WSTAR	0	#N/A
PRECIP	0	#N/A
SENSHEAT	0	#N/A
CONVZI	0	#N/A
LDB	F	#N/A
NN1	1	#N/A
NN2	1	#N/A
IOUTD	0	#N/A
NZPRN2	0	#N/A
IPR0	0	#N/A
IPR1	0	#N/A
IPR2	0	#N/A
IPR3	0	#N/A
IPR4	0	#N/A
IPR5	0	#N/A
IPR6	0	#N/A
IPR7	0	#N/A
IPR8	0	#N/A
NOOBS	2	#N/A
NSSTA	0	User Defines
NPSTA	-1	User Defines
ICLOUD	3	0
IFORMS	2	2
IFORMP	2	2
IFORMC	2	2
IWFCOD	1	1
IFRADJ	1	1
IKINE	1	0
IOBR	0	0
ISLOPE	1	1
IEXTRP	-1	-4
ICALM	0	0
BIAS	0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0	NZ*0
RMIN2	-1	4
IPROG	14	0
ISTEPPG	1	#N/A
LVARY	F	F
RMAX1	30	User Defines
RMAX2	30	User Defines
RMAX3	50	User Defines
RMIN	0.1	0.1
TERRAD	12	User Defines

Variable	IDNR Value	IWAQM Default
R1	1	User Defines
R2	1	User Defines
RPROG	0.1	#N/A
DIVLIM	0.000005	0.000005
NITER	50	50
NSMTH	2 , 4 , 4 , 4 , 4 , 4 , 4 , 4 , 4 , 4 , 4 , 4	2, 4*(NZ-1)
NINTR2	99, 99, 99, 99, 99, 99, 99, 99, 99, 99, 99, 99	99
CRITFN	1	1
ALPHA	0.1	0.1
FEXTR2	0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.	#N/A
NBAR	0	#N/A
XBBAR	0	#N/A
YBBAR	0	#N/A
XEBAR	0	#N/A
YEBAR	0	#N/A
IDIOPT1	0	0
ISURFT	4	User Defines
IDIOPT2	0	0
IUPT	2	User Defines
ZUPT	200	200
IDIOPT3	0	0
IUPWND	-1	-1
ZUPWND	1., 1000.	1, 1000
IDIOPT4	0	0
IDIOPT5	0	0
LLBREZE	F	#N/A
NBOX	0	#N/A
XG1	0	#N/A
XG2	0	#N/A
YG1	0	#N/A
YG2	0	#N/A
XBCST	0	#N/A
YBCST	0	#N/A
XECST	0	#N/A
YECST	0	#N/A
NLB	0	#N/A
METBXID	0	#N/A
CONSTB	1.41	1.41
CONSTE	0.15	0.15
CONSTN	2400	2400
CONSTW	0.16	0.16
FCORIOL	0.0001	0.0001
IAVEZI	1	#N/A
MNMDAV	1	1
HAFANG	30	30
ILEVZI	1	1
DPTMIN	0.001	0.001

Variable	IDNR Value	IWAQM Default
DZZI	200	200
ZIMIN	50	50
ZIMAX	3448	3000
ZIMINW	50	50
ZIMAXW	3448	3000
ITPROG	2	#N/A
IRAD	1	1
TRADKM	36	500
NUMTS	5	5
IAVET	1	1
TGDEFB	-0.0098	-0.0098
TGDEFA	-0.0045	-0.0045
JWAT1	55	999
JWAT2	55	999
NFLAGP	2	2
SIGMAP	50	100
CUTP	0.01	0.01

10.6 APPENDIX: CALPUFF

The following table provides a listing of the variables and subsequent values utilized in the IDNR CALPUFF model plant configuration for the CALPUFF model. The default values recommended by the IWAQM workgroup are provided for comparison. A value of "#N/A" indicates a default setting was not provided in the IWAQM Appendices.

Variable	IDNR Value	IWAQM Default
PUFLST	cpuf.lst	CALPUFF.LST
CONDAT	cpuf.con	CONC.DAT
LCFILES	T	#N/A
NMETDAT	365	#N/A
NPTDAT	0	#N/A
NARDAT	0	#N/A
NVOLDAT	0	#N/A
METDAT	inndir/cmet.20020101.dat *(an example)*	CALMET.DAT
METRUN	0	0
IBYR	2002	User Defined
IBMO	1	User Defined
IBDY	1	User Defined
IBHR	1	User Defined
XBTZ	6	#N/A
IRLG	8760	User Defined
NSPEC	6	5
NSE	3	3
ITEST	2	#N/A
MRESTART	0	0
NRESPD	0	#N/A
METFM	1	1
AVET	60	60
PGTIME	60	#N/A
MGAUSS	1	1
MCTADJ	3	3
MCTSG	0	0
MSLUG	0	0
MTRANS	1	1
MTIP	1	1
MBDW	2	#N/A
MSHEAR	0	0
MSPLIT	1	0
MCHEM	1	1
MAQCHEM	0	#N/A
MWET	1	1
MDRY	1	1
MDISP	3	3
MTURBVW	3	3
MDISP2	3	3
MROUGH	0	0

Variable	IDNR Value	IWAQM Default
MPARTL	1	1
MTINV	0	0
MPDF	0	0
MSGTIBL	0	0
MBCON	0	#N/A
MFOG	0	#N/A
MREG	1	1
CSPEC	SO2	#N/A
CSPEC	SO4	#N/A
CSPEC	NOX	#N/A
CSPEC	HNO3	#N/A
CSPEC	NO3	#N/A
CSPEC	PM10	#N/A
SO2	1, 1, 1, 0	#N/A
SO4	1, 0, 2, 0	#N/A
NOX	1, 1, 1, 0	#N/A
HNO3	1, 0, 1, 0	#N/A
NO3	1, 0, 2, 0	#N/A
PM10	1, 1, 2, 0	#N/A
PMAP	LCC	#N/A
FEAST	0	#N/A
FNORTH	0	#N/A
IUTMZN	19	User Defined
UTMHEM	N	#N/A
RLAT0	40N	#N/A
RLON0	97W	#N/A
XLAT1	33N	#N/A
XLAT2	45N	#N/A
DATUM	WGS-G	#N/A
NX	171	User Defined
NY	165	User Defined
NZ	12	User Defined
DGRIDKM	12	User Defined
ZFACE	0., 20., 40., 73., 146., 369., 598., 1071., 1569., 2095., 2462., 2942., 3448.	User Defined
XORIGKM	-792	User Defined
YORIGKM	-720	#N/A
IBCOMP	10	User Defined
JBCOMP	10	User Defined
IECOMP	162	User Defined
JECOMP	156	User Defined
LSAMP	F	F
IBSAMP	10	User Defined
JBSAMP	10	User Defined
IESAMP	162	User Defined
JESAMP	156	User Defined
MESHDN	1	1

Variable	IDNR Value	IWAQM Default
ICON	1	1
IDRY	1	1
IWET	1	1
IVIS	1	1
LCOMPRS	T	T
IMFLX	0	#N/A
IMBAL	0	#N/A
ICPRT	0	0
IDPRT	0	0
IWPRT	0	0
ICFRQ	1	1
IDFRQ	1	1
IWFRQ	1	1
IPRTU	3	1
IMESG	2	1
SO2	0, 1, 0, 1, 0, 1, 0	#N/A
SO4	0, 1, 0, 1, 0, 1, 0	#N/A
NOX	0, 1, 0, 1, 0, 1, 0	#N/A
HNO3	0, 1, 0, 1, 0, 1, 0	#N/A
NO3	0, 1, 0, 1, 0, 1, 0	#N/A
PM10	0, 1, 0, 1, 0, 1, 0	#N/A
LDEBUG	F	F
IPFDEB	1	#N/A
NPFDEB	1	#N/A
NN1	1	#N/A
NN2	10	#N/A
NHILL	0	#N/A
NCTREC	0	#N/A
MHILL	2	#N/A
XHILL2M	1	#N/A
ZHILL2M	1	#N/A
XCTDMKM	0	#N/A
YCTDMKM	0	#N/A
SO2	0.1509, 1000., 8., 0., 0.04	#N/A
NOX	0.1656, 1., 8., 5., 3.5	#N/A
HNO3	0.1628, 1., 18., 0., 0.00000008	#N/A
SO4	0.48, 2.	#N/A
NO3	0.48, 2.	#N/A
PM10	0.48, 2.	#N/A
RCUTR	30	30
RGR	10	10
REACTR	8	8
NINT	9	9
IVEG	1	1
SO2	3.0E-05, 0.0E00	#N/A
SO4	1.0E-04, 3.0E-05	#N/A
NOX	0.0E00, 0.0E00	#N/A

Variable	IDNR Value	IWAQM Default
HNO3	6.0E-05, 0.0E00	#N/A
NO3	1.0E-04, 3.0E-05	#N/A
PM10	1.0E-04, 3.0E-05	#N/A
MOZ	0	1
BCKO3	40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00	80
BCKNH3	3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00	10
RNITE1	0.2	0.2
RNITE2	2	2
RNITE3	2	2
MH2O2	1	#N/A
BCKH2O2	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00	#N/A
BCKPMF	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00	#N/A
OFRAC	0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15	#N/A
VCNX	50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00	#N/A
SYTDEP	550	550
MHFTSZ	0	#N/A
JSUP	5	5
CONK1	0.01	0.01
CONK2	0.1	0.1
TBD	0.5	0.5
IURB1	10	10
IURB2	19	19
ILANDUIN	20	20
Z0IN	0.25	#N/A
XLAIIN	3	3
ELEVIN	0	0
XLATIN	0	User Defined
XLONIN	0	User Defined
ANEMHT	10	10
ISIGMAV	1	1
IMIXCTDM	0	0
XMXLEN	1	1
XSAMLEN	1	1
MXNEW	99	99
MXSAM	99	99
NCOUNT	2	#N/A
SYMIN	1	1
SZMIN	1	1
SVMIN	0.500, 0.500, 0.500, 0.500, 0.500, 0.500	6*0.50
SWMIN	0.200, 0.120, 0.080, 0.060, 0.030, 0.016	0.20, 0.12, 0.08, 0.06, 0.03, 0.016
CDIV	.0, .0	0.01
WSCALM	0.5	0.5

Variable	IDNR Value	IWAQM Default
XMAXZI	3448	3000
XMINZI	50	50
WSCAT	1.54, 3.09, 5.14, 8.23, 10.80	1.54,3.09,5.14,8. 23.10.8
PLX0	0.07, 0.07, 0.10, 0.15, 0.35, 0.55	0.07,0.07,0.10,0. 15,0.35,0.55
PTG0	0.020, 0.035	#N/A
PPC	0.50, 0.50, 0.50, 0.50, 0.35, 0.35	0.5,0.5,0.5,0.5,0. 35,0.35
SL2PF	10	10
NSPLIT	2	3
IRESPLIT	0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0	User Defined
ZISPLIT	100	100
ROLDMAX	0.25	0.25
NSPLITH	5	#N/A
SYSPLITH	1	#N/A
SHSPLITH	2	#N/A
CNSPLITH	0.0000001	#N/A
EPSSLUG	0.0001	0.0001
EPSAREA	0.000001	#N/A
DSRISE	1	#N/A
HTMINBC	500	#N/A
RSAMPBC	10	#N/A
MDEPBC	1	#N/A
NPT1	1	User Defined
IPTU	4	1
NSPT1	0	0
NPT2	0	0
SRCNAM	STK1	#N/A
X	294.0, 246.0, 55.0, 333.5, 2.6, 11.4, 414, .0, 2.5E3, 0.0E00, 2.5E3, 0.0E00, 0.0E00, 5.0E01	#N/A
FMFAC	1	#N/A
NAR1	0	#N/A
IARU	1	#N/A
NSAR1	0	#N/A
NAR2	0	#N/A
NLN2	0	#N/A
NLINES	0	#N/A
ILNU	1	#N/A
NSLN1	0	#N/A
MXNSEG	7	#N/A
NLRISE	6	#N/A
XL	0	#N/A
HBL	0	#N/A
WBL	0	#N/A
WML	0	#N/A
DXL	0	#N/A
FPRIMEL	0	#N/A
NVL1	0	#N/A
IVLU	1	#N/A

Variable	IDNR Value	IWAQM Default
NSVL1	0	#N/A
NVL2	0	#N/A
NREC	360	User Defined

10.7 Appendix: POSTUTIL

The following table provides a listing of the variables and subsequent values utilized in the IDNR CALPUFF model plant configuration for the POSTUTIL postprocessor.

Variable	IDNR Value
UTLLST	pstu.lst
UTLDAT	pstu.con
NMET	365
NFILES	1
LCFILES	T
UTLMET	/r1/calpuff/calmet/12km_12z/2002/cmet.20021230.dat *(an example)*
MODDAT	cpuf.con
ISYR	2002
ISMO	1
ISDY	1
ISHR	1
NPER	8760
NSPECINP	6
NSPECOUT	6
NSPECCMP	0
MDUPLCT	1
NSCALED	0
MNITRATE	1
BCKNH3	3
ASPECI	SO2
ASPECI	SO4
ASPECI	NOX
ASPECI	HNO3
ASPECI	NO3
ASPECI	PM10
ASPECO	SO2
ASPECO	SO4
ASPECO	NOX
ASPECO	HNO3
ASPECO	NO3
ASPECO	PM10

10.8 Appendix: CALPOST

The following table provides a listing of the variables and subsequent values utilized in the IDNR CALPUFF model plant configuration for the CALPOST postprocessor.

Variable	IDNR Value
MODDAT	input-pstu.con
PSTLST	cpst.lst
VUNAM	vis
LCFILES	T
METRUN	0
ISYR	2002
ISMO	1
ISDY	1
ISHR	1
NHRS	8760
NREP	1
ASPEC	VISIB
ILAYER	1
A	0
B	0
LBACK	F
LG	F
LD	T
LCT	F
LDRING	F
NDRECP	-1
IBGRID	-1
JBGRID	-1
IEGRID	-1
JEGRID	-1
NGONOFF	0

Variable	IDNR Value
RHMAX	95
LVSO4	T
LVNO3	T
LVOC	F
LVPMC	F
LVPMF	T
LVEC	F
LVBK	T
SPECPMC	PMC
SPECPMF	PM10
EEPMC	0.6
EEPMF	1
EEPMCBK	0.6
EESO4	3
EENO3	3
EEOC	4
EESOIL	1
EEEC	10
MVISBK	6
RHFAC	see: Table 5-8, Table 5-9, Table 5-10
BKSO4	see: Table 5-8, Table 5-9, Table 5-10
BKNO3	see: Table 5-8, Table 5-9, Table 5-10
BKPMC	see: Table 5-8, Table 5-9, Table 5-10
BKOC	see: Table 5-8, Table 5-9, Table 5-10
BKSOIL	see: Table 5-8, Table 5-9, Table 5-10
BKEC	see: Table 5-8, Table 5-9, Table 5-10

Variable	IDNR Value
BEXTRAY	10
LDOC	F
IPRTU	3
L1HR	F
L3HR	F
L24HR	T
LRUNL	F
NAVG	0
LT50	F
LTOPN	F
NTOP	4
ITOP	1,2,3,4
LEXCD	F
THRESH1	-1
THRESH3	-1
THRESH24	-1
THRESHN	-1
NDAY	0
NCOUNT	1
LECHO	F
LTIME	F
IECHO	366*0
LPLT	F
LGRD	F
LDEBUG	F

11. CAMX APPENDICES

Analyses pertaining to the CAMx cumulative modeling scenarios focused primarily upon the maximum impacts and the frequency of impacts above 0.5 dv. The investigation of maximum impacts is informative but provides little context regarding relational magnitudes of the immediate subordinate data. The following tables are therefore provided to supply additional detail. For each scenario modeled, the Class I area specific top ten delta deciview impacts are listed, along with the corresponding date of occurrence. Ranked data for both the annual average and the 20% best natural background conditions are provided. The ranked impacts, in relation to current (2002) visibility conditions, are provided for the 12km simulation to compliment Table 6-6.

The data show atmospheric conditions in August and September generally yield the highest impacts at nearby Class I areas. In review of all ranked impacts, greater temporal variability is encountered and the importance of annual episodes becomes clear. A final feature of the datasets is a tendency for a disproportionate increase in visibility impacts when comparing the highest and second highest impacts, versus other rankings. For example, in scenario k2002ia36b0v2r2 under annual average natural background conditions the maximum impact at MING is 0.41 dv while the second high is 0.20 dv, a difference of 0.21 dv. The next largest step decrease is roughly 1/7th this range, at 0.03 dv (and occurs between the 5th and 6th highest values). These tendencies are only moderate in prevalence, as exceptions are easily found (e.g. BADL in scenario k2002ia36b0v2r1). The transition to a 12km grid also eases this gradient. In summary, while not critical in subject to BART determinations, expanding the visibility impact analysis beyond maximum impacts to include the top ten values provides additional insight and perspective.

11.1 APPENDIX: K2002IA36B0V2R1 RANKED VISIBILITY IMPACTS

k2002ia36b0v2r1: Annual Average Natural Background															
RANK	BADL	Date	BOWA	Date	HEGL	Date	ISLE	Date	MING	Date	SENE	Date	VOYA	Date
1	2.23	8/20/2002	2.97	9/18/2002	2.65	12/14/2002	2.70	4/15/2002	2.34	8/25/2002	3.17	11/29/2002	2.40	9/18/2002
2	2.02	8/27/2002	2.72	9/6/2002	2.29	9/16/2002	2.60	9/18/2002	1.53	4/22/2002	1.99	11/28/2002	1.92	10/1/2002
3	1.61	8/21/2002	2.14	10/1/2002	2.27	12/6/2002	2.27	9/17/2002	1.41	9/16/2002	1.94	9/18/2002	1.88	9/30/2002
4	1.22	8/26/2002	2.10	9/17/2002	1.47	4/22/2002	2.21	9/6/2002	1.27	8/26/2002	1.93	7/17/2002	1.85	9/6/2002
5	1.08	8/4/2002	1.97	9/30/2002	1.32	4/2/2002	2.14	6/30/2002	1.11	5/26/2002	1.86	7/27/2002	1.78	12/11/2002
6	0.99	8/6/2002	1.84	6/30/2002	1.31	5/26/2002	1.89	9/2/2002	0.98	6/6/2002	1.62	9/17/2002	1.74	9/1/2002
7	0.98	8/5/2002	1.76	4/15/2002	1.14	9/17/2002	1.86	4/14/2002	0.87	11/19/2002	1.49	9/14/2002	1.46	1/4/2002
8	0.94	7/14/2002	1.60	9/7/2002	0.96	11/17/2002	1.74	10/1/2002	0.82	2/4/2002	1.45	8/12/2002	1.43	8/30/2002
9	0.88	9/29/2002	1.58	8/30/2002	0.92	11/27/2002	1.52	7/16/2002	0.79	9/17/2002	1.25	12/13/2002	1.39	9/17/2002
10	0.76	5/11/2002	1.55	1/4/2002	0.92	9/11/2002	1.51	9/30/2002	0.78	4/23/2002	1.23	12/10/2002	1.35	9/7/2002

k2002ia36b0v2r1: 20% Best Natural Background														
RANK	BADL	Date	BOWA	Date	HEGL	Date	ISLE	Date	MING	Date	SENE	Date	VOYA	Date
1	2.79	8/20/2002	4.16	9/18/2002	3.72	12/14/2002	3.72	4/15/2002	3.32	8/25/2002	4.41	11/29/2002	3.41	9/18/2002
2	2.53	8/27/2002	3.83	9/6/2002	3.24	9/16/2002	3.68	9/18/2002	2.16	4/22/2002	2.83	11/28/2002	2.72	10/1/2002
3	2.03	8/21/2002	3.01	10/1/2002	3.21	12/6/2002	3.23	9/17/2002	2.03	9/16/2002	2.79	9/18/2002	2.69	9/30/2002
4	1.55	8/26/2002	3.00	9/17/2002	2.08	4/22/2002	3.15	9/6/2002	1.84	8/26/2002	2.74	7/17/2002	2.65	9/6/2002
5	1.38	8/4/2002	2.82	9/30/2002	1.89	5/26/2002	3.00	6/30/2002	1.60	5/26/2002	2.66	7/27/2002	2.53	12/11/2002
6	1.26	8/6/2002	2.61	6/30/2002	1.88	4/2/2002	2.71	9/2/2002	1.43	6/6/2002	2.34	9/17/2002	2.50	9/1/2002
7	1.25	8/5/2002	2.48	4/15/2002	1.66	9/17/2002	2.61	4/14/2002	1.26	11/19/2002	2.16	9/14/2002	2.10	1/4/2002
8	1.20	7/14/2002	2.30	9/7/2002	1.39	11/17/2002	2.46	10/1/2002	1.19	2/4/2002	2.10	8/12/2002	2.06	8/30/2002
9	1.11	9/29/2002	2.28	8/30/2002	1.33	9/11/2002	2.18	9/30/2002	1.16	9/17/2002	1.80	12/13/2002	2.01	9/17/2002
10	0.97	5/11/2002	2.21	1/4/2002	1.33	11/27/2002	2.17	7/16/2002	1.12	4/23/2002	1.78	12/10/2002	1.95	9/7/2002

11.2 APPENDIX: K2002IA36B0V2R2 RANKED VISIBILITY IMPACTS

k2002ia36b0v2r2: Annual Average Natural Background

RANK	BADL	Date	BOWA	Date	HEGL	Date	ISLE	Date	MING	Date	SENE	Date	VOYA	Date
1	0.15	8/20/2002	0.62	9/6/2002	0.38	12/14/2002	0.64	4/15/2002	0.41	8/25/2002	0.58	9/18/2002	0.36	9/6/2002
2	0.15	2/16/2002	0.42	9/18/2002	0.34	4/2/2002	0.51	9/6/2002	0.20	9/16/2002	0.40	9/17/2002	0.34	9/18/2002
3	0.12	10/15/2002	0.36	1/4/2002	0.29	10/26/2002	0.51	4/14/2002	0.18	6/6/2002	0.38	9/14/2002	0.33	1/4/2002
4	0.11	5/30/2002	0.32	4/15/2002	0.27	4/9/2002	0.50	6/30/2002	0.18	8/26/2002	0.30	2/6/2002	0.28	8/30/2002
5	0.11	8/5/2002	0.30	9/30/2002	0.27	12/6/2002	0.42	9/18/2002	0.18	4/2/2002	0.29	7/17/2002	0.25	12/11/2002
6	0.10	11/5/2002	0.27	12/11/2002	0.25	2/24/2002	0.40	7/16/2002	0.15	11/28/2002	0.26	7/27/2002	0.24	9/30/2002
7	0.10	7/13/2002	0.27	6/30/2002	0.22	8/26/2002	0.31	1/4/2002	0.14	4/5/2002	0.26	1/4/2002	0.22	4/14/2002
8	0.09	3/19/2002	0.26	9/7/2002	0.20	11/27/2002	0.27	9/17/2002	0.14	12/25/2002	0.26	12/10/2002	0.21	1/3/2002
9	0.09	8/22/2002	0.25	1/3/2002	0.20	10/27/2002	0.25	12/10/2002	0.14	2/1/2002	0.24	12/19/2002	0.19	8/29/2002
10	0.08	4/28/2002	0.24	4/14/2002	0.19	12/10/2002	0.25	9/19/2002	0.13	11/25/2002	0.24	4/14/2002	0.19	7/21/2002

k2002ia36b0v2r2: 20% Best Natural Background

RANK	BADL	Date	BOWA	Date	HEGL	Date	ISLE	Date	MING	Date	SENE	Date	VOYA	Date
1	0.20	8/20/2002	0.91	9/6/2002	0.57	12/14/2002	0.92	4/15/2002	0.60	8/25/2002	0.85	9/18/2002	0.53	9/6/2002
2	0.19	2/16/2002	0.62	9/18/2002	0.49	4/2/2002	0.76	9/6/2002	0.29	9/16/2002	0.60	9/17/2002	0.51	9/18/2002
3	0.16	10/15/2002	0.52	1/4/2002	0.43	10/26/2002	0.73	4/14/2002	0.27	6/6/2002	0.56	9/14/2002	0.49	1/4/2002
4	0.14	5/30/2002	0.46	4/15/2002	0.39	12/6/2002	0.73	6/30/2002	0.26	8/26/2002	0.44	2/6/2002	0.42	8/30/2002
5	0.14	8/5/2002	0.45	9/30/2002	0.39	4/9/2002	0.62	9/18/2002	0.26	4/2/2002	0.43	7/17/2002	0.36	12/11/2002
6	0.13	11/5/2002	0.41	12/11/2002	0.36	2/24/2002	0.59	7/16/2002	0.22	11/28/2002	0.39	7/27/2002	0.36	9/30/2002
7	0.13	7/13/2002	0.39	6/30/2002	0.33	8/26/2002	0.46	1/4/2002	0.21	12/25/2002	0.38	1/4/2002	0.32	4/14/2002
8	0.12	3/19/2002	0.39	9/7/2002	0.29	11/27/2002	0.40	9/17/2002	0.21	4/5/2002	0.38	12/10/2002	0.31	1/3/2002
9	0.11	8/22/2002	0.37	1/3/2002	0.29	10/27/2002	0.36	9/19/2002	0.21	2/1/2002	0.36	12/19/2002	0.28	8/29/2002
10	0.11	4/28/2002	0.36	8/30/2002	0.28	12/10/2002	0.36	12/10/2002	0.20	11/25/2002	0.35	4/14/2002	0.28	6/19/2002

11.3 Appendix: k2002ia12b0v2r2 Ranked Visibility Impacts

k2002ia12b0v2r2: Annual Average Natural Background

RANK	BADL	Date	BOWA	Date	HEGL	Date	ISLE	Date	MING	Date	SENE	Date	VOYA	Date
1	0.24	9/28/2002	0.63	9/6/2002	0.52	12/14/2002	0.62	7/16/2002	0.34	8/25/2002	0.43	9/18/2002	0.53	9/18/2002
2	0.17	8/20/2002	0.57	9/18/2002	0.49	4/9/2002	0.54	6/30/2002	0.26	11/6/2002	0.34	9/14/2002	0.36	9/6/2002
3	0.12	7/13/2002	0.29	9/7/2002	0.38	4/2/2002	0.49	4/15/2002	0.26	9/16/2002	0.27	12/19/2002	0.27	8/30/2002
4	0.11	4/28/2002	0.28	12/11/2002	0.28	11/15/2002	0.39	9/17/2002	0.23	5/26/2002	0.26	7/17/2002	0.24	12/11/2002
5	0.11	7/12/2002	0.28	7/21/2002	0.28	8/27/2002	0.37	9/18/2002	0.22	8/26/2002	0.23	7/27/2002	0.24	6/29/2002
6	0.10	3/7/2002	0.27	10/1/2002	0.25	8/26/2002	0.34	9/2/2002	0.21	6/6/2002	0.22	7/21/2002	0.24	9/30/2002
7	0.09	8/5/2002	0.25	9/2/2002	0.25	9/16/2002	0.33	9/6/2002	0.21	8/27/2002	0.21	2/6/2002	0.23	7/21/2002
8	0.09	9/10/2002	0.24	9/30/2002	0.24	10/26/2002	0.28	4/14/2002	0.20	4/5/2002	0.20	7/1/2002	0.23	5/29/2002
9	0.08	8/27/2002	0.24	4/15/2002	0.22	11/27/2002	0.26	9/7/2002	0.18	12/14/2002	0.19	12/10/2002	0.22	4/15/2002
10	0.08	8/23/2002	0.22	8/9/2002	0.19	10/27/2002	0.21	8/10/2002	0.16	4/10/2002	0.18	6/25/2002	0.22	8/9/2002

k2002ia12b0v2r2: 20% Best Natural Background

RANK	BADL	Date	BOWA	Date	HEGL	Date	ISLE	Date	MING	Date	SENE	Date	VOYA	Date
1	0.30	9/28/2002	0.93	9/6/2002	0.76	12/14/2002	0.90	7/16/2002	0.50	8/25/2002	0.64	9/18/2002	0.78	9/18/2002
2	0.21	8/20/2002	0.84	9/18/2002	0.70	4/9/2002	0.78	6/30/2002	0.39	11/6/2002	0.51	9/14/2002	0.53	9/6/2002
3	0.15	7/13/2002	0.43	9/7/2002	0.55	4/2/2002	0.71	4/15/2002	0.38	9/16/2002	0.40	12/19/2002	0.41	8/30/2002
4	0.14	4/28/2002	0.41	12/11/2002	0.42	11/15/2002	0.57	9/17/2002	0.34	5/26/2002	0.39	7/17/2002	0.36	12/11/2002
5	0.14	7/12/2002	0.41	7/21/2002	0.42	8/27/2002	0.55	9/18/2002	0.33	8/26/2002	0.34	7/27/2002	0.36	6/29/2002
6	0.13	3/7/2002	0.39	10/1/2002	0.37	8/26/2002	0.50	9/2/2002	0.32	8/27/2002	0.32	7/21/2002	0.36	9/30/2002
7	0.12	8/5/2002	0.37	9/2/2002	0.36	9/16/2002	0.49	9/6/2002	0.32	6/6/2002	0.31	2/6/2002	0.34	7/21/2002
8	0.11	9/10/2002	0.35	9/30/2002	0.36	10/26/2002	0.40	4/14/2002	0.29	4/5/2002	0.30	7/1/2002	0.33	5/29/2002
9	0.10	8/27/2002	0.34	4/15/2002	0.33	11/27/2002	0.39	9/7/2002	0.27	12/14/2002	0.28	12/10/2002	0.33	8/9/2002
10	0.10	8/23/2002	0.32	8/9/2002	0.27	10/27/2002	0.30	8/10/2002	0.24	10/14/2002	0.27	9/17/2002	0.33	4/15/2002

k2002ia12b0v2r2: Current Conditions

RANK	BADL	Date	BOWA	Date	HEGL	Date	ISLE	Date	MING	Date	SENE	Date	VOYA	Date
1	0.12	9/28/2002	0.11	9/6/2002	0.11	4/9/2002	0.19	7/16/2002	0.08	10/14/2002	0.13	9/14/2002	0.10	6/29/2002
2	0.08	9/10/2002	0.11	7/21/2002	0.11	8/26/2002	0.13	6/30/2002	0.08	1/15/2002	0.08	12/7/2002	0.10	7/21/2002
3	0.06	7/12/2002	0.10	9/18/2002	0.10	4/2/2002	0.12	2/14/2002	0.06	10/7/2002	0.08	9/18/2002	0.10	9/18/2002
4	0.06	8/20/2002	0.08	6/29/2002	0.08	1/17/2002	0.11	9/17/2002	0.06	5/26/2002	0.08	9/17/2002	0.09	8/9/2002
5	0.06	2/26/2002	0.08	9/5/2002	0.08	12/14/2002	0.09	9/18/2002	0.06	4/22/2002	0.07	2/14/2002	0.08	4/15/2002
6	0.05	7/13/2002	0.08	8/9/2002	0.07	8/27/2002	0.08	4/15/2002	0.06	8/25/2002	0.06	2/7/2002	0.07	9/6/2002
7	0.05	5/12/2002	0.08	8/15/2002	0.07	2/1/2002	0.06	11/7/2002	0.06	6/6/2002	0.06	7/16/2002	0.07	4/14/2002
8	0.05	5/9/2002	0.07	10/10/2002	0.06	8/25/2002	0.06	8/10/2002	0.05	11/6/2002	0.05	7/17/2002	0.07	5/21/2002
9	0.05	8/22/2002	0.07	5/21/2002	0.06	11/15/2002	0.06	6/7/2002	0.05	5/3/2002	0.05	1/4/2002	0.06	5/29/2002
10	0.04	5/25/2002	0.06	5/28/2002	0.05	2/10/2002	0.06	4/14/2002	0.04	4/5/2002	0.05	2/6/2002	0.06	9/5/2002